POWER

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The Know-it-All

"I DON'T have to read no more" was the response of a complacent and self-satisfied knight of the throttle to an invitation to subscribe.

He had won his spurs. He could probably keep an engine, perhaps a whole steam plant, running as it ought to run.

And he did not have to hunt directions how to do it in any book, either.

He had arrived, he had!

And he is going to stay right there where he is.

It means nothing to him that new ideas, new apparatus, new methods and processes are being evolved all the time. He has no concern for the results that others are attaining and how they get them.

He is a finished product.

He does not want any inspiration that might disturb his serene self-sufficiency and enlist his interest and talent in some of the many possibilities for improvement by which others will profit in the next ten years.

The biggest and best engineers think that they have to read and study; that they must keep themselves informed as to the direction that development is taking, as to the improvements that are being made, the possibilities and limitations of new processes and apparatus and to have a try-out at some of the problems that arise with exploring practice.

There is hope for the man who knows not and knows that he knows not, but pitiful is the plight of the man who knows it all.

F. R. Low

New Power Plant of the Bryant Paper Co.

Modern central plant of 8,000-kw. ultimate capacity, designed to supply power, steam and hot water to the four divisions of a large paper mill, replaces a combination of individual boiler plants and scattered engine units. Features of special interest are the balancing of power and heating steam, an interesting system involving economizers supplying in unison hot water to the boilers and the mills, special coal- and ash-handling, automatic control and complete metering facilities.

AT KALAMAZOO, MICH., the Bryant Paper Company is just completing the first section of a central power station designed to replace eventually five separate boiler plants and a large number of small engine units located at various points in the works to be in near proximity to the driven machines or lineshafts. The first section of the new power plant, consisting of four boilers, a 2,000-kw. unaflow engine generating unit with a second machine of the same size to go in, and a 500-kw. auxiliary non-condensing turbo-generator, is to be duplicated with the exception of the turbine unit, in the near future. At that time, with all the mills electrified, the power and heating steam will practically balance. The operating force will be reduced, duplication of coal and ash handling will be eliminated, and with the concentration into one large modern plant, greatly improved combustion and high boiler-room economy are to be anticipated. All these factors point to an enormous saving over former conditions that should soon pay for the new station.

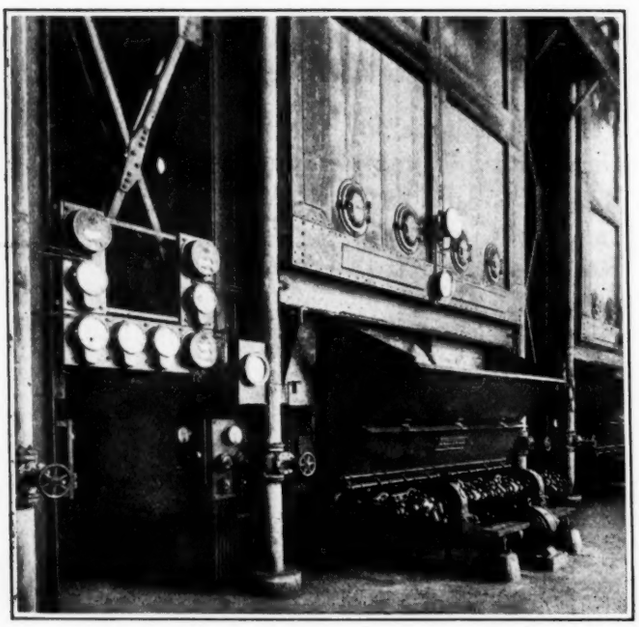


Fig. 1—One of the boilers showing instrument board

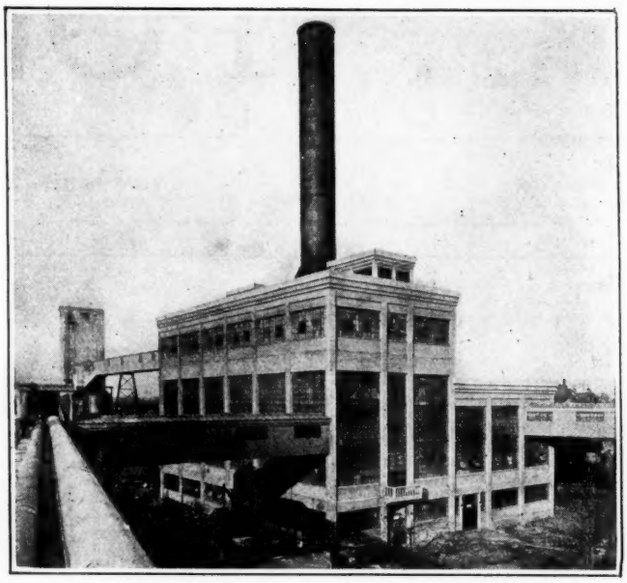


Fig. 2—Exterior view of new central power house

Serving the four divisions of the manufacturing plant there was a total of thirty-four water-tube boilers, thirty of which were equipped with top-feed stokers, one with an underfeed stoker and the other three hand-fired. Thirty-two engines, eight of which were operated condensing and the rest non-condensing, were distributed about the property where most convenient to operate the driven machines or equipment. With the long steam lines, small boiler and engine units, operating pressures approximating 125 lb. gage, and the duplication of personnel and equipment to operate a number of obsolete plants, it does not need much stretch of the imagination to see that economies must have been below present standards. Recognizing these conditions, the management, in 1921, retained V. D. Simons, consulting industrial engineer, of Chicago, to make a complete survey of the property and offer recommendations pertaining to economies in all branches of the manufacturing plants.

Centralization of Power and Steam Supply

An outstanding feature of the report was a recommendation for the centralization of power and steam supply and the electrification of the mills. It was deemed advisable to divide such an extensive program into two parts, the first involving the following schedule: Rehabilitation and electrification of the Superior division, electrification of the Imperial Coating division and the supplying of medium-pressure steam at 150 lb. gage for the Bryant division. The two original boiler plants of the division last named were shut down and the headers connected to the steam supply from the new plant. This division generally was rehabilitated and will be electrified when the second portion of the program is carried out. In the Milham division the power plant has been retained for the time being, and there will be electrical interconnection between it and the new power plant.

The power requirements with the first portion of the program complete, were found to be in the neighborhood of 2,000 kw., with practically a constant load and a

high load factor as the mills operate twenty-four hours a day and six full days a week, the shutdown period being from 7 a.m. Sunday to the same hour Monday. The exhaust-steam demand ranged from 43,000 to 65,000 lb. an hour, so that with a prime-mover capacity of 2,000 kw., at a steam rate of 21 lb. a kw.-hr., a practical balance was to be anticipated.

A central site was selected for the new plant to minimize the length of transmission lines, both steam and electric. To meet the requirements previously outlined, four boilers of the bent-tube type were installed. The plan is to operate these boilers at 200 per cent of rating, so that, normally, three boilers will be in service and one a stand-by unit. To secure the low water rate desired of the generating unit, 21 lb. per kw.-hr. at 10 lb. back pressure, required favorable steam conditions, so that the boilers are to carry steam at 300 lb. gage pressure superheated 200 deg. F. when the boiler duty is 200 per cent of the rated capacity.

The boilers are set singly in a row, and the duplicate installation to be made later will continue this row to a total of eight boilers. The superheaters are between the first and second banks of tubes. An outlet flue serving two boilers in common carries the gases to an economizer on the floor above or through a bypass directly to the induced-draft fan located between the economizer and a steel stack placed centrally to serve the four boilers. A similar arrangement of smoke flue, economizer and induced-draft fan is placed on the other side of the stack for the other two boilers.

Of special interest are the induced-draft fans, which are of the single-width, single-inlet type with a wheel 126 in. in diameter, an inlet diameter of 84 in. and an outlet 69x69 in. The drive is a 75-hp. shunt-wound direct-current motor having a speed range of 115 to 240 r.p.m. varied by field control. Within this range the power requirements run from 6 to 75 hp. for outputs ranging from 35,500 to 95,000 cu.ft. of air per minute. The fans have top vertical discharge outlets from which the flues of 33⅓ sq.ft., enlarging to 60 sq.ft., sectional area, discharge, one into either side of the stack, the final length of flue entering the stack above the roof line at the easy angle of 45 deg. to minimize friction and with a partition at the center of the stack to eliminate interference of one side with the other. The various areas of air and gas passages are summarized in Table I.

Underfeed stokers with eight retorts and compressed-air-operated ash dumps serve each boiler. The furnaces are equipped with ventilated anti-clinkering blocks and tuyeres in the front walls. The stoker drive is a direct-current motor set on the boiler-room floor in front of the stoker.

Air to the stokers is supplied by individual forced-draft fans set under the windboxes on the basement floor in a compartment isolated from the dust and dirt of the plant. There is no interconnection between units. Each fan is of the double-inlet, full-housed type with inlet screen, louver-type outlet damper and structural-steel motor pedestal for direct connection to a 50-hp. direct-current motor. The speed range is from 400 to 860 r.p.m., and within these limits the output of air per minute is from 15,000 to 31,000 cu.ft. and the power requirements from 5 to 50 hp.

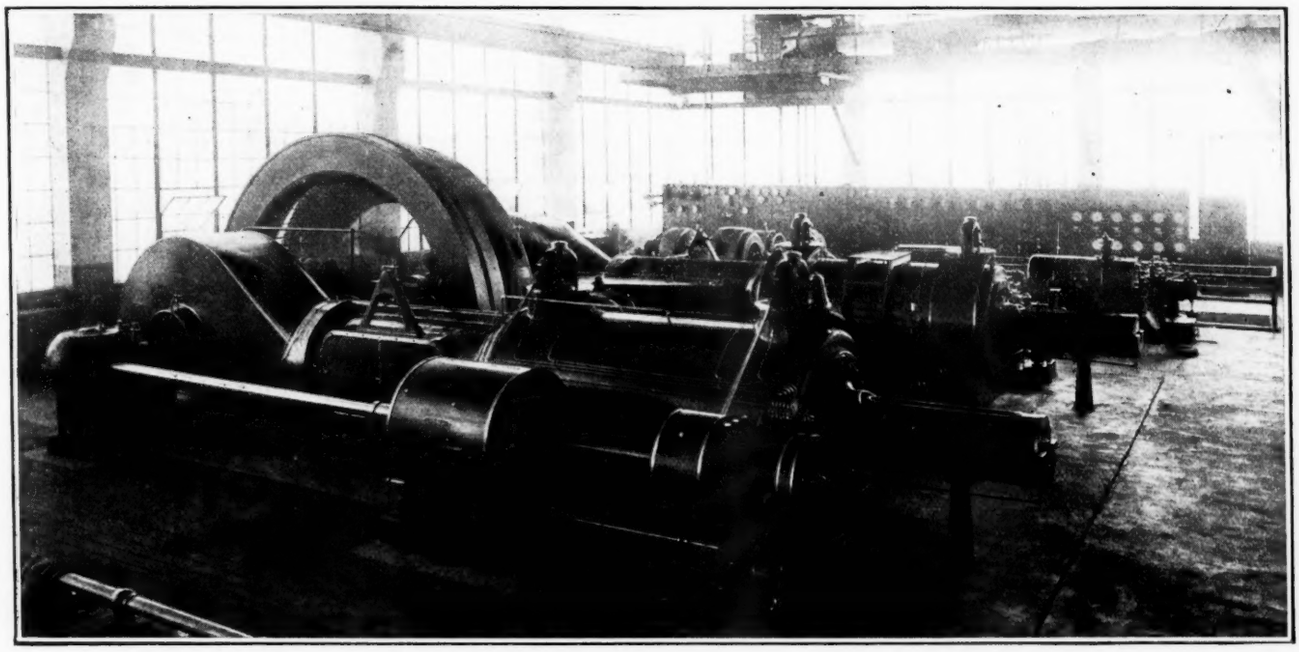


Fig. 3—Duplex unaflow engine driving 2,000-kw. generator, turbo-generator in background

TABLE I—AREAS OF AIR AND GAS PASSAGES

	Number	Area Sq.Ft.	Area Sq.In. per 10 Sq.Ft. Boiler Heating Surface
Forced draft fan outlet	4	33	1.53
Stoker blast damper	8	48	2.22
Ashpit blast damper	8	6	0.28
Total blast inlet	16	54	2.50
Boiler dampers	4	133	6.15
Economizer bypasses	2	119	5.50
Economizer inlets	2	170	7.88
Economizer outlets	2	153	7.18
Induced-draft fan outlets	2	67	3.10
Stack inlets	2	120	5.55
Stack inside	1	128	5.93

Combustion in the plant as a whole and in the individual boiler furnaces is controlled by the Gray system, with steam-pressure and furnace-air controllers and other mechanism to regulate the coal and air supply with the steam demand and to maintain a balanced draft

condition in the furnace. The steam-pressure regulator controls the stoker speed and the speed of the forced-draft and induced-draft fans, while the furnace regulator varies the position of the louver dampers in the forced-draft ducts, thus controlling the quantity of air going to the individual furnace. As the steam pressure drops, the stoker and the fans speed up. This requires a readjustment of the blast dampers by the furnace regulator consistent with the thickness and condition of the individual fuel bed to maintain a predetermined pressure over the fire. For a rise in steam pressure the operation of the control mechanism is the reverse.

One of the interesting features of the boiler room is the high-pressure steam piping, which is of steel throughout with steel valves and fittings and Sargol welded joints, all designed for 450 lb. pressure. To solve the expansion problem a header of the spider type just long enough to receive the various connections has been provided. From each boiler 8-in. leads drop down to this header, which is 14 in. in diameter and about 12 ft. long. It is provided with a sectionalizing valve at the center, and on either side a 10-in. lead will supply the twin engine of the generating unit

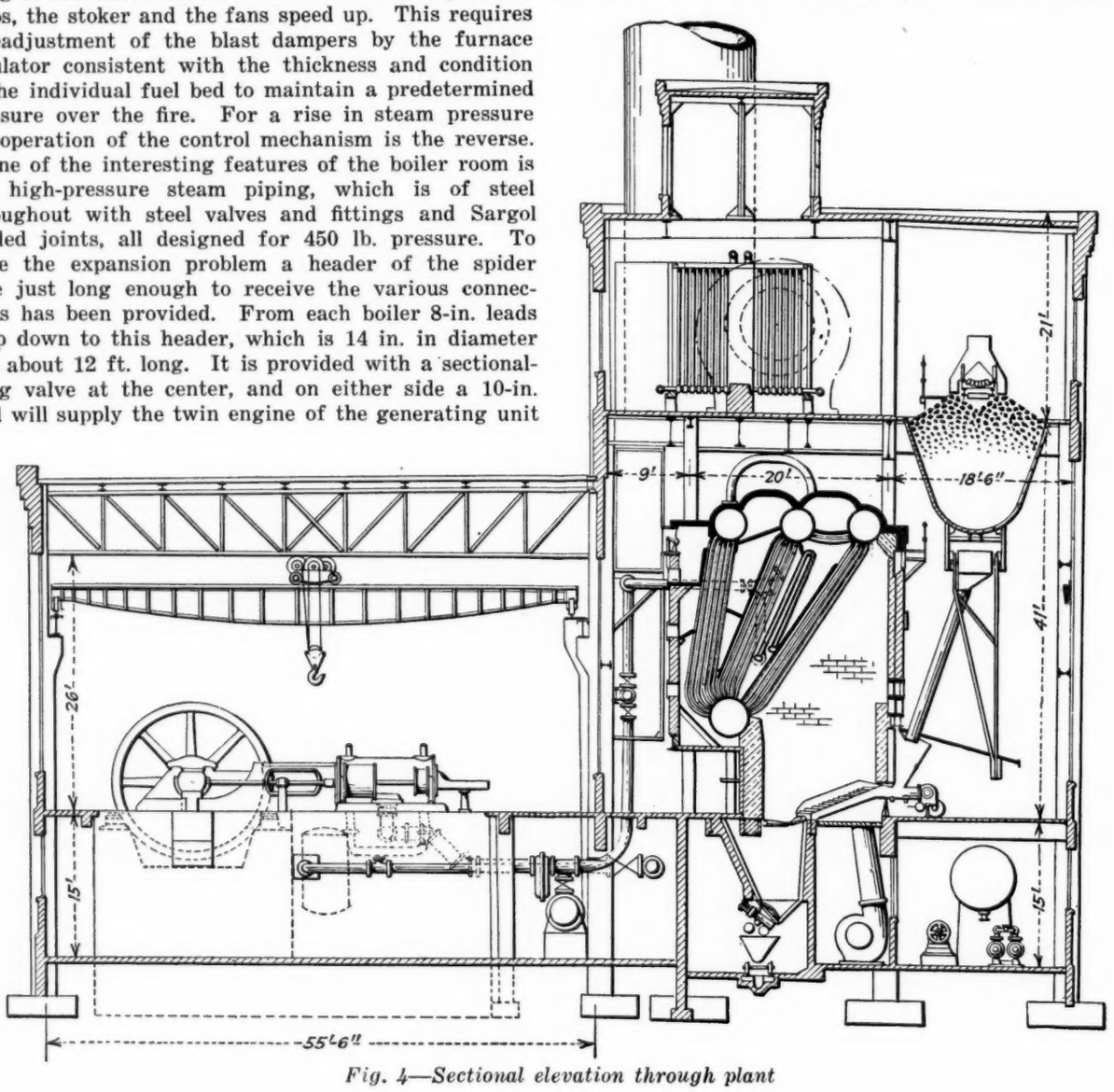


Fig. 4—Sectional elevation through plant

now installed and the future unit to go in this section of the plant. Specially looped connections lead from the receiver to either side of the twin engine. A U-connection leading to either side of the sectionalizing valve in the header supplies steam for the auxiliaries, and from the end of the header steam, reduced to 150 lb. gage and desuperheated, is supplied to the Bryant mill. This steam line, as well as the hot-water lines and electric cables, are conducted overhead on structural-steel bridgework from the power plant to the various points of distribution. Rollers and slides and the usual pipe supports are in evidence, and a walkway gives ready access to the various lines.

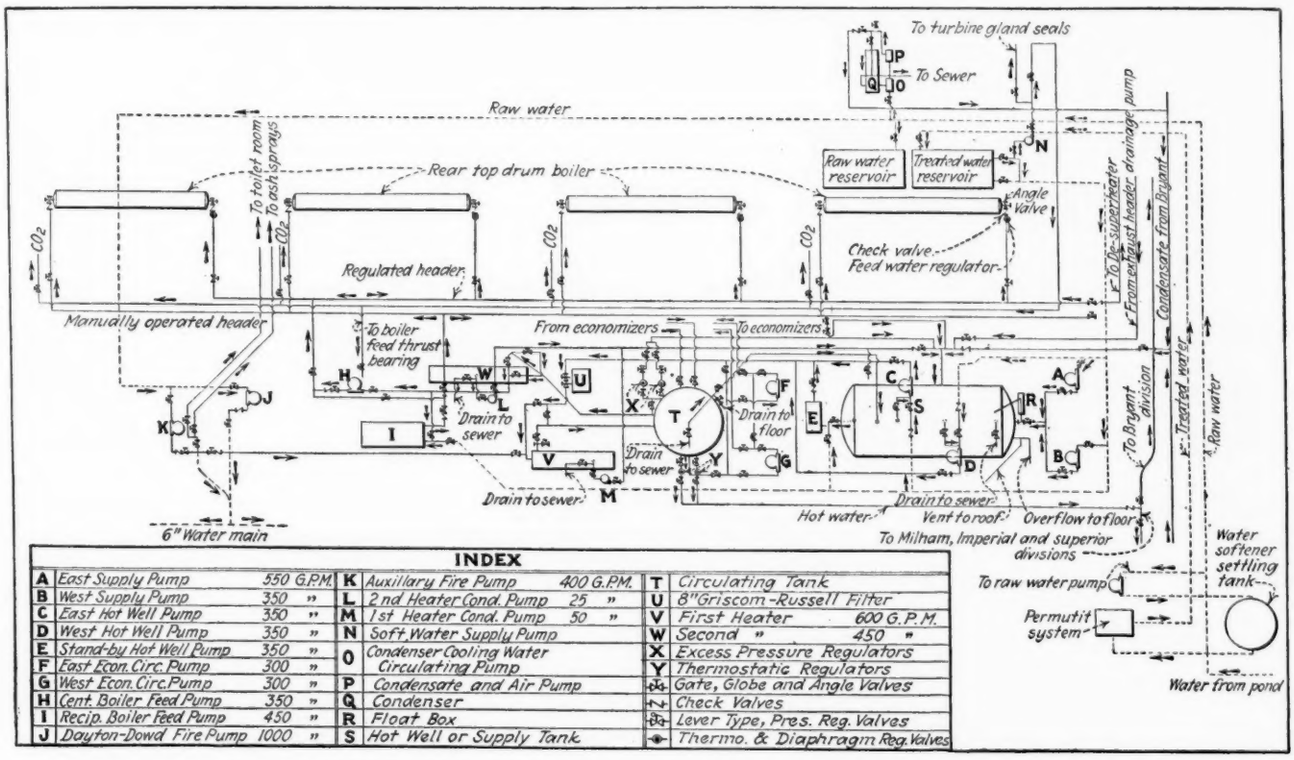
Perhaps the most interesting feature of the plant is the water-distribution system and the method of heating by economizers the water for boiler and mill supply. Originally, the water is drawn from a 60-acre pond on the premises, fed by springs and the watershed south of Kalamazoo. This is the main raw-water supply for the boilers, mills and condensing purposes, and as it contains from 14 to 18 grains of incrusting solids per gallon, a water-softening system was considered essential, in particular as only 50 per cent of the returns will come back eventually to the boiler house. A double system having a capacity of 600 gal. per min., in which the impurities are removed in two stages, was installed. The cold process with lime and soda ash is first employed, and to reduce it to zero hardness the water is then subjected to the zeolite process. After the water has been softened, it is stored in a concrete reservoir in the power plant, and adjacent is a second reservoir containing raw water from the pond. From this point the single-line diagram, Fig. 5, shows the system in operation in the power plant.

A large receiving tank or hotwell, marked *S* in the drawing, receives the returns and all the clean drips from the plant. The level in this tank is maintained by the float valve *R*, which automatically controls either

one of the two motor-driven pumps, *A* and *B*, drawing their supply either from the treated-water or the raw-water reservoirs. From the large horizontal receiving tank either one of two motor-driven centrifugal pumps, *C* and *D*, pass the water through an 8-in. pressure filter *U* and a closed heater *V* to the vertical receptacle *T* called the economizer tank, the heater being employed to raise the temperature of the water to 125 deg., to exceed the dew point of the economizers. Should pumps *C* and *D* both fail to function, a direct-acting steam pump *E* is automatically cut in to maintain the supply of water to the economizer tank. Deaëration of the boiler-feed water is provided for over another line direct to the first closed heater.

It so happens in the paper industry that there is a large demand for soft water in the de-inking process, and this water must be at a temperature above 212 deg. F. It was this demand that opened the possibilities of combining the process water and the boiler feed and utilizing economizers to extract the necessary heat from the waste gases. The economizers are therefore served by low-service pumps, *F* and *G* in the diagram, and the heated water is returned to the storage tank *T* in the basement, from which suction is taken for boiler-feeding purposes and discharge is made of mill process water, both connections being from the top of the tank, where the hot water, raised 100 deg. in temperature by the economizers, is to be obtained. By thermostatically operated valves the flow to the mill is stopped when the temperature drops below 200 deg. F. and resumes when this figure is exceeded. The economizer system is maintained full of water at 70 lb. pressure, and excess-pressure regulators are provided to permit discharge to the main receiving tank *S* should this pressure be exceeded.

Water for boiler feed is drawn from the top of the circulating tank *T* and, to insure a temperature equal to that of exhaust steam at 7 to 10 lb. pressure, is passed through a second closed heater *W*. This service is performed by the motor-driven centrifugal pump *H* or the reciprocating boiler feed pump *I*, both of which also have connections to the raw-water supply line for emergency service. The centrifugal pump is intended for continuous service, while the reciprocating duplex pump of equal capacity floats on the system ready to take up the burden. A reserve turbine-driven centrifugal pump is provided for Sunday and holiday service. By the centrifugal pump delivery is made to the main feed-water header which supplies the boilers under automatic control. The reserve pump has connections to this header and also to an auxiliary header from which the feed is manually controlled. It will be seen



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A	East Supply Pump	550 G.P.M.	K	Auxiliary Fire Pump	400 G.P.M.	T	Circulating Tank
B	West Supply Pump	350 "	L	2nd Heater Cond. Pump	25 "	U	8" Griscom-Russell Filter
C	East Hot Well Pump	350 "	M	1st Heater Cond. Pump	50 "	V	First Heater 600 G.P.M.
D	West Hot Well Pump	350 "	N	Soft Water Supply Pump		W	Second " 450 "
E	Stand-by Hot Well Pump	350 "	O	Condenser Cooling Water Circulating Pump		X	Excess Pressure Regulators
F	East Econ. Circ. Pump	300 "				Y	Thermostatic Regulators
G	West Econ. Circ. Pump	300 "	P	Condensate and Air Pump			Gate, Globe and Angle Valves
H	Cent. Boiler Feed Pump	350 "	Q	Condenser			Check Valves
I	Recip. Boiler Feed Pump	450 "	R	Float Box			Lever Type, Pres. Reg. Valves
J	Dayton-Dowd Fire Pump	1000 "	S	Hot Well or Supply Tank			Thermo. & Diaphragm Reg. Valves

Fig. 5—Diagrammatic sketch of water distribution system

that the two heaters are provided with pumps *L* and *M*, to return the condensate to the main receiving tank, and that bypass connections are provided to eliminate either heater if desired. Both *J* and *K* are motor-driven pumps, the former a fire pump and the latter an auxiliary pump which has connection to supply in an emergency, through heater *V*, raw water to the economizer storage tank.

Another feature of the power plant that should prove of inestimable value in maintaining high economy and lowering operating costs is a most complete system of metering. Provisions have been made to weigh the coal, meter the feed water, measure the steam flow from each boiler, the output of steam to the several services outside of the power plant, and the steam to the station auxiliaries. Other flow meters measure the steam to the engine and turbine units. Recording meters on the various steam services mentioned are

mounted on panels forming an extension to the main switchboard in the engine room, shown in the background of Fig. 3.

In the boiler room operating conditions are visualized to the firemen by a complete equipment of indicating and recording instruments, all of which are mounted on panels at the boiler fronts and arranged between the settings in full view of the boiler-room attendants. There are instruments to indicate the steam pressure, the steam flow in horsepower from each boiler, the total steam temperature and the temperature of the gases in the last pass of the boiler. Three-pointer gages show the air pressure under the grates, the draft over the fire and the draft in the last pass of the boiler. Two-pointer gages give the draft on the breeching and stack sides of the economizers. There are also multi-pointer

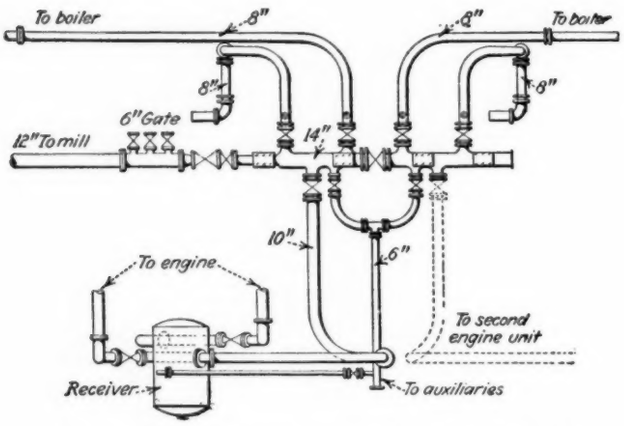


Fig. 6—High-pressure steam header and piping to engine unit

gages for giving the temperature of the gases and also of the water entering and leaving the economizers, a recording thermometer on the feed water and a CO_2 recorder for each boiler. Here also are ammeters showing the load on the fan and stoker motors and push-button control for starting and stopping, with rheostats to effect manually small changes in speed. Full automatic control equipment for the motors is mounted on a special board in the basement.

Coal for the plant is delivered by rail and is transferred from car to overhead bunker in the boiler room by a combination skip hoist and belt conveyor system having a capacity to handle 90 tons of coal an hour. The hoist and tower is 100 ft. from the present building to permit the intended addition to the plant without disturbing the present coal-handling arrangement, which has capacity for the ultimate plant. Delivery from the railway car is made into a track hopper from which a loader fills the bucket of the skip hoist, in which it is raised to an elevation of 90 ft. and dumped into a hopper. Below the hopper is a grizzley separating the fine and the coarse coal, the latter passing through the crusher and the fine coal bypassing it, with final delivery onto a 24-in. belt conveyor having a horizontal run of 220 ft. An automatic tripper on this belt delivers the coal to the overhead bunker in the boiler room, having capacity to hold 450 tons of coal, or approximately three days' supply. Delivery from the bunker is made to a one-ton traveling weigh larry from which the weight of coal to each stoker hopper is secured. The system is motor-driven throughout and is under push-button control with operating stations at convenient points. The wiring arrangement is such that the conveyor belt must start first and the equipment in order back to the skip hoist. In stopping, the sequence is reversed.

Large Storage Provided

At present there is yard storage facilities for 12,000 tons, although there is plenty of space to provide for storage up to 40,000 tons. The coal is unloaded into storage by a locomotive crane, and when reclaiming, the same equipment loads the coal back into the car, from which it is transferred to the bunker by the method previously described. The coal to be burned in the plant will be from the eastern Kentucky and West Virginia fields, of nut, pea and slack sizes containing approximately 13,500 B.t.u. as fired.

There is also a skip hoist for handling ashes. It is on the opposite side of the tower from the coal hoist and in an emergency may be used as a coal hoist, a throw-over valve above the ash-storage tank insuring proper delivery of the coal to the crusher or to the horizontal belt conveyor. It will be seen that a railway track hopper has been provided, and into this the ashes are dumped from industrial cars hauled by a storage-battery tractor. The cars are loaded directly from the ash hoppers under the stokers. These hoppers are equipped with ash sprinkling lines and gates operated by compressed-air cylinders. From the track hopper the ashes are elevated in the skip hoist and delivered to a 60-ton tank supported by the steelwork of the tower, with a bottom chute for delivery to railway cars.

Factors Governing Selection of Prime Mover

When it came to selecting a prime mover for the power load, a water rate not exceeding 21 lb. per kw.-hr. was the guiding factor, as the previous analysis had shown that this economy against 10 lb. back pressure must be secured to insure a practical balance between the power and heating steam. For such economy against the back pressure stated, it was a foregone conclusion that the prime mover must be an engine and that the steam conditions must be more favorable than had been common with reciprocating units. The final choice rested with a duplex unaflow engine driving a 2,000-kw. generator at a speed of 120 r.p.m., with the guaranteed water rates given in the table of equipment. So far as known this is one of the largest unaflow-engine-driven generating units that have been built in this country, and when completed, the plant is to have four of these units.

In the engine an interesting feature is incorporated in that one cylinder may be operated condensing while the other is operating against back pressure. An automatic device maintains a constant pressure in the exhaust main. The condenser will be of some advantage during the summer months when no exhaust steam is required for heating the buildings. It will be eliminated when the second portion of the program is carried out.

For an auxiliary machine that would carry the load during the shut-down periods on Sundays and holidays and supply whatever exhaust steam might be needed, a unit that would operate with the least amount of attention was desired. For this service a non-condensing turbine was selected having particularly favorable

performance guarantees. The machine is rated at 500 kw. and under the same operating conditions as given for the engine, is guaranteed to deliver a kilowatt-hour on 25 lb. of steam at full load.

Excitation for the main engine-driven unit is supplied by a 200-kw. synchronous-motor-driven exciter set which has sufficient capacity for three additional generating units to be installed. A 300-kw. direct-current machine, also driven by a synchronous motor, supplies the energy for the forced- and induced-draft fan motors and the stoker motors. These synchronous motors also have the function of maintaining the power factor above 90 per cent, as most of the motors throughout the mill are of the induction type, designed for 2,300 volts when exceeding 50-hp. capacity and for 440-volt three-phase service when the rating is below 50 horsepower.

The entire plant was designed and the erection supervised by V. D. Simons, consulting industrial engineer, of Chicago. The resident engineer on the work was F. P. Gilligan, and the engineer in charge of starting operations was J. W. McElroy. E. C. Rutz is superintendent of power and maintenance for the Bryant Paper Company, and D. H. Zwart is chief operating engineer in the new station.

DATA ON EQUIPMENT IN BYRANT POWER PLANT

GENERAL

Location	Kalamazoo, Mich.
Service	Industrial
Capacity, kva	3,000
Ultimate capacity, kva	8,000
Boiler house, ft	47.5x111
Engine room, ft	55.5x111
Width firing aisle, ft	18

BOILERS AND SUPERHEATERS

Manufacturer	Babcock & Wilcox Co.
Type of boiler	Stirling water tube
Number installed	4
Steam-making surface per boiler, sq.ft.	7,787
Ratio steam-making surface to projected grate area	48 to 1
Furnace volume, cu.ft.	2,350
Steam-making surface per cu.ft. of furnace volume, sq.ft.	3.3
Furnace volume per sq.ft. of projected grate area, su.ft.	14.5
Arrangement of tubes	28 tubes wide
Size of tubes, in.	3½
Boiler pressure, lb. gage	300
Superheater	Babcock & Wilcox Co.
Type	Integral
Location	Between first and second bank of tubes
Steam temperature at 200 per cent rating, deg.F	622
Corresponding superheat, deg. F.	200

FUEL

Kind	Kentucky or West Virginia coal
Heat value, B.t.u. per lb.	13,500
Soot-blowers	Diamond Power Specialty Corp.

STOKERS

Manufacturer	Combustion Engr. Corp.
Type	Frederick underfeed
Number per boiler	1
Width, ft.	14
Actual grate area, sq.ft.	168
Projected grate area, sq.ft.	161.6
Retorts per stoker	8
Pounds coal per sq.ft. grate area at 200 per cent rating	5,300

Efficiencies at different boiler ratings:

Per Cent of Rating	Combined Boiler and Furnace Efficiency, per Cent
100	78
150	78
200	75.5

BOILER CONTROL SYSTEM

Forced draft fans and motors, stoker motors, damper regulators, induced draft fans and motors, automatic control system.	
Forced draft fans, manufacturer	Clarage Fan Co.
Number of fans	4
Capacity for fan, cu.ft. per min. at 5-in. stat. pressure	35,000
Induced draft fans, manufacturer	Clarage Fan Co.
Number of fans	2
Capacity of fan, cu.ft. per min. at 3.5 in stat. pressure	104,000
Stoker and fan drives	Westinghouse d.c. motors
Combustion regulation	Automatic Fuel Saving Co.
Electrical features of fuel saving system	Westinghouse Elec. & Mfg. Co.

ECONOMIZERS

Manufacturer	Green Fuel Economizer Co.
Type	C.I. Sectional
Number	Two of 2 banks each
Surface of each, sq.ft.	8,150

STACK

Manufacturer	Chicago Bridge & Iron Works
Number	1
Type	Self-supporting steel lined above induced draft fan inlets
Height from base, ft	125
Height above boiler floor, ft.	166
Diameter inside, ft.	13
Area at top, sq.ft.	133
Boilers per stack	4
Ratio stack area at top to steam making surface	1 to 233
Stack lining, Non-Pariel block	Armstrong Cork and Insulation Co.

PUMPS

Boiler feed, two centrifugal, 350 and 200 g.p.m.	Worthington Pump & Mach. Corp.
Boiler feed, one reciprocating, 350 g.p.m.	Union Steam Pump Co.
Fire pump, motor-driven cent., 1,000 g.p.m., (Dayton-Dowd Co.)	Fire Pump and Equipment Co.
Service pump, motor-driven cent., 400 g.p.m.	Union Steam Pump Co.
Supply pumps, two cent., motor-dr., 350 and 550 g.p.m.	Union Steam Pump Co.
Supply tank pumps, two cent., motor dr.; one reciprocating, 350 g.p.m.	Union Steam Pump Co.
Econ. circ. pumps, two cent., motor dr., 300 g.p.m.	Union Steam Pump Co.
Heater condensate pumps, two cent., motor dr., 100 g.p.m.	Union Steam Pump Co.

HEATERS

Manufacturer	Patterson-Kelley Co.
Number and type	2-horizontal; closed
Capacity, lb. per hr.	225,000 and 300,000
Pressure filter, 8 in.	Elliott Co.

COAL-HANDLING

Manufacturer	R. H. Beaumont Mfg. Co.
Type	Coal and ash skip hoists with belt conveyor and automatic tripper over suspended coal bunker
Capacity, tons coal per hour	90
Capacity, tons ashes per hour	60
Crusher, one double-roll, tons per hour	90
Overhead bunker, 400 tons	R. H. Beaumont Mfg. Co.
Yard coal storage	Present 12,000 tons; future, 40,000 tons
Reclaiming method	Locomotive cranes

MAIN GENERATING UNITS

One engine-driven generating unit, kva	2500
Engine, duplex unaflow, 28x48 in., 120 r.p.m.	Nordberg Mfg. Co.
Generator, 2500 kva., 2300 v., 3 ph., 60 cycle,	Westinghouse Elec. & Mfg. Co.
Steam conditions at throttle	275 lb. gage, 200 deg. F. superheat
Economy guarantees when operating against 10 lb. back pressure:	
Full load, lb. per kw.-hr.	19.5
¾ load, lb. per kw.-hr.	19.9
½ load, lb. per kw.-hr.	21.4
Condenser, surface, 1800 sq.ft.	Union Steam Pump Co.
One turbo-generator unit, non-condensing	Allis-Chalmers Mfg. Co.
Turbine capacity at 3,600 r.p.m., kva.	625
Generator capacity	625 kva., 2,300 v., 3 ph., 60 cy.
Steam conditions at throttle	275 lb. gage, 200 deg. F. superheat
Economy guarantees when operating against 10 lb. back pressure:	
Full load, lb. per kw.-hr.	25
¾ load, lb. per kw.-hr.	27.2
½ load, lb. per kw.-hr.	31.3
One motor-generator set for excitation	Westinghouse Elec. & Mfg. Co.
Motor, synchronous, 220 volts, hp.	290
Generator, direct current, 250 volts, kw.	200
One motor-generator set, direct current boiler auxiliary	Westinghouse Elec. & Mfg. Co.
Motor, synchronous, 2,200 volts, hp.	432
Generator, direct-current, 250 volts, kw.	300
Switchboard	Westinghouse Elec. & Mfg. Co.

WATER-SOFTENING SYSTEM

Manufacturer	Permutit Company
Type	Lime and soda softener, cold process and zeolite process
Capacity, gal. per min.	36,000
Deaërating system, 180,000 lb. per hour	Elliott Co.

MISCELLANEOUS EQUIPMENT AND MATERIALS

Station crane, 25 tons	Whiting Corp.
Feed-water regulators	"S-C" Regulator Mfg. Co.
Blow off valves	A. W. Cadman Mfg. Co.
Non-return valves	Crane Co.
Safety valves	Crane Co.
Steam valves	Crane Co.
Water valves	Crane Co.
Piping	Crane Co.
Piping covering	Johns-Manville, Inc.—Smith Totman & Co.
Pump governors	"S.C." Regulator Mfg. Co.; Fisher Governor Co.
Steam-flow meters	Republic Flow Meters Co.
Feed-water meter	Republic Flow Meters Co.
Multi-pointer draft gages	Foxboro Co., Inc.
Recording thermometers	Taylor Instrument Co.'s
CO_2 recorders	Republic Flow Meters Co.
Steam pressure gages (Ashcroft)	Manning, Maxwell & Moore
Water columns	Reliance Gauge Column Co.
Boiler settings	Edward Nelson & Co.
Firebrick	A. P. Green Fire Brick Co.
Ash cars	Chase Foundry & Mfg. Co.
Storage-battery tractor	Koppel Ind. Car & Equip. C
Receiver separators	Hamler Boiler & Tank Co.
Oil filtering and storage system	The Griscom-Russell Co.
Tanks, hotwell, economizer and blowoff	Hamler Boiler & Tank Co.

Load Control in Automatic Hydro-Electric Generating Stations

By R. C. DENNY
Operating Engineer, San Joaquin Light and Power Corporation

IN THE automatic or semi-automatic operation of hydro-electric generating stations the proper adjustment of load to correspond to water conditions is probably the most difficult if not the most important single accomplishment. The great majority of such stations are old and relatively unimportant small installations that have been the pioneer plants of their respective systems. Unimportant to their systems from a capacity viewpoint, they are still valuable from the output viewpoint, provided they can be operated economically enough to compete with their big brothers, the modern plants of today. Thus we find the automatic or semi-automatic plants tied in on large systems and operating to get the most output from the water they have available and within their capacity.

It is at this point of efficiency of operation that the automatic adjustment of load becomes important. Obviously any plant must maintain some certain effective head to operate most efficiently. Any considerable variation from that particular elevation will affect the efficiency of operation. Variation of flow or water supply is common to all hydro-electric plants, whether it be the natural stream-flow variation or due to control

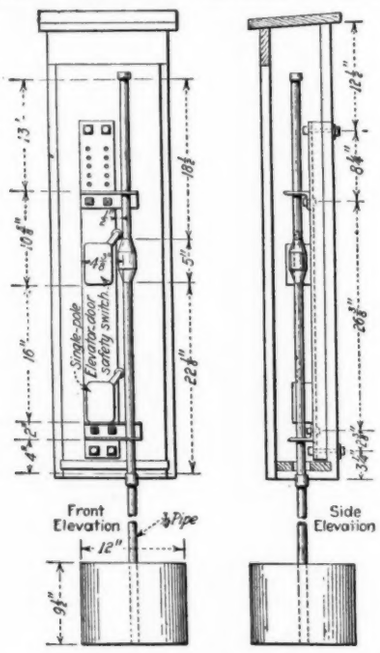


Fig. 1—Details of float construction

of stored water. The plant then must vary its load to meet any variation in its water supply and thus maintain a nearly constant head. The foregoing, of course, does not apply to governing plants that must operate more or less in conformity with their systems' load curves, drawing on storage to meet peaks and storing during off-peak periods.

The float-control method of making load changes in hydro-electric plants will be found to be in most general use. Pressure systems are widely used to indicate elevations, but are hardly positive or reliable enough to be used for the more strenuous service of load control. The standard float, as used on the system of the San

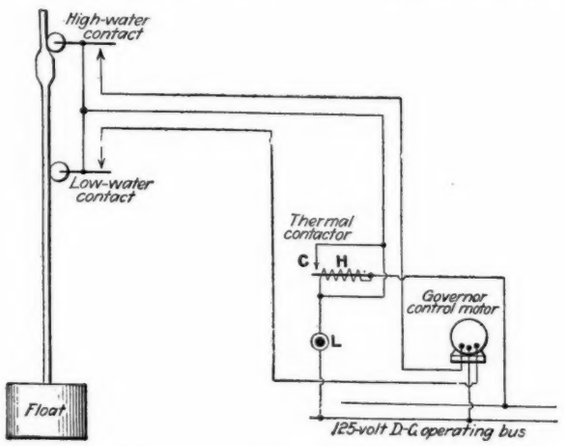


Fig. 2—Diagram of connection for governor control where no storage is available at the plant

Joaquin Light & Power Corp., Fresno, Calif., is shown in Fig. 1, which, without going into details, should give anyone a sufficient idea of its construction to build one similar to it. In connection with this float the writer has developed two methods of periodically operating the governor control motor to increase or reject load as the need might be, depending on water conditions. Both methods utilize standard apparatus only slightly modified, so that the arrangement may easily be duplicated by any company having need of such devices.

The first and simpler method of the two is more applicable to plants that have little or no forebay storage, in fact, no forebay at all other than a pressure box of some sort to permit spillage incidental to loss of load. In plants of this type the problem of load control is comparatively simple because load changes result in quick water changes and relatively quick return of the float to normal or neutral position. Referring to Fig. 2, we have the three wires from the float switch connected with the governor control motor and its direct-current source through a thermal contactor, which device is nothing more nor less than a thermostatic flasher. It is one of the substantial types on the market, having heavy contacts and a capacity of 220 watts. The heating element *H* of the thermostat is connected in series with a 60-watt mazda lamp *L* at all times, which results in a continuous though negligible current consumption. The action of the control is as follows:

The current drawn by the lamp through *H* causes the thermocouple to expand and close contact *C*. This shunts out the heating coil, the lamp receiving the full current, after which the thermocouple cools off and

contact *C* opens. This action is repeated continuously, the intervals of closed and open contact being on the order of 2 and 3 sec., which may be varied by adjustment of the contacts or using lamps of different wattage. Consider that the high-water contact closes during an interval that contact *C* is closed. Then current will pass through the thermocouple and operate the governor-control motor to pick up load. The contact is then broken in a few seconds, as already outlined, and the motor stops. If not enough load has been picked up in the first interval to change the float position, the

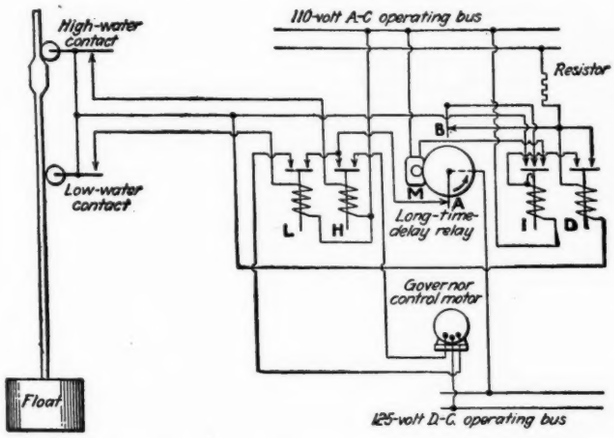


Fig. 3—Diagram of connections for governor control where there is storage at the plant

motor will operate immediately on reclosure of contact *C*. The operation is the same for low-water contact except that the governor-control motor is reversed, causing load to be rejected.

Load Control Where Water Storage Is Available

In plants that operate on little or no storage, the previously described scheme is effective, as one or two operations will usually be enough to cause the float switch to open. It is obvious, however, that such a scheme would not be satisfactory in forebays of any considerable capacity, as the control motor would operate so many times before the water could draw down or rise enough to break contact that the governor would greatly overtravel one way or the other. Therefore, another method, Fig. 3, was devised to give greater time intervals than was possible with any thermal device. Relays *L*, *H*, *I* and *D* are of the standard plunger-type of well-known manufacture, all of current operated type, 3-ampere rating. All except *D* are of the instantaneous type, relay *I* having a third contact and flexible connection to the plunger contact. D is of the definite-time-delay type. The long-time-delay relay is also standard although not in extensive use, owing to the rather special nature of its applications. The explanation of this method of operation follows:

Consider that the high-water contact closes; this puts alternating-current on relays *H* and *D*. Relay *H* picks up instantly, putting direct-current on the governor-control motor through contact *A* to pick up some load. Obviously, the motor must not operate too long, or too much load would be picked up. Relay *D* in the meantime is closing its contacts in a definite time of 2 or 3 sec. or whatever is found to be the proper interval. Immediately on closing its contacts, relay *I* is energized and picks up instantly. On closing its contacts three things are accomplished simultaneously: (1) Energy is maintained on *I* through contact *B* and flexible connection entirely independent of relay *D*, and holds in. (2) Relay *D* is shunted out and opens, taking its normal position. (3) The long-time-delay relay starts owing to the action of the synchronous motor, which is energized through contact *B*. Contact *A* opens at once and stops the governor-control motor, all this within 2 or 3 sec. after the float first contacts.

Motor *M* continues to operate, moving arm *A* around through 180 deg. in a definite time of 5 to 25 min., depending upon what may be found necessary to allow the forebay to draw down. At the end of this interval contact *B* is opened by lever *A* and, provided the high-water contact has broken in the meantime, motor *M* stops and the lever *A* resets; also relay *I* is de-energized, taking its normal position and breaking the shunt around relay *D*. If, however, not enough load had been picked up and the high-water contact is still maintained, the governor control motor will start immediately when contact *A* recloses, and relay *D*, receiving energy immediately on having its shunt broken, begins to time the operation as before. The operation for low-water contact is just the same except that relay *L* is operated instead of *H* to reverse the governor-control motor and reject load.

It is, of course, possible to rebuild clock mechanisms to accomplish results similar to those obtained through the methods just reviewed. However, it is doubtful if the same ease of control over the short- and long-time delays could be had without getting into quite a complicated and expensive machine. It is the thought of the writer therefore, that such adaptations of standard relays and devices to special purposes may prove useful and valuable data to operating men.

Injection Air Pressure for Diesel Engines

Each design of fuel-valve atomizer requires a certain air pressure to inject the oil properly. This pressure will vary with the resistance, or "braking" action, of the atomizer disks. It follows that no set of air-pressure values can be given which will apply to all engines.

The engineer should recognize that on light loads the injection pressure must be lower than is required on full load. If the pressure is not reduced, the air will "slug" the oil into the cylinder since there is practically no atomizer resistance. The engine will then smoke badly. Conversely, with full-load fuel charges a low air pressure will not be sufficient to force the large oil charge through the disks.

Still another condition necessitates higher pressure on full load. When the engine is carrying a heavy load, the cylinder heats up, causing the fresh charge of air in the engine cylinder to have a higher terminal pressure, resulting from the increased absorption of heat. To obtain a given pressure drop in the atomizer, the air injection pressure must be increased.

It is necessary for oil to be as free from acid as possible, and to determine whether or not acid is present, place the oil in a glass vessel and add a small quantity of copper oxide. If acid is present the oil will change to green or blue. If not, no change will take place. Litmus paper can be used for the same test, as it turns red when a slight trace of acid is present.

Jacob Perkins and His Descendants

Four Generations of Engineers, Inventors of High-Pressure Steam Boilers—Unaflow Engines—High-Economy Triple-Expansion Marine Engines

BY CHARLES R. KING

Jacob Perkins, 1766-1849

IT IS seldom that an inventive genius bequeaths like power to his descendants. On the other hand, four generations of the Perkins family distinguished themselves by the boldness of their ideas and the practicability of many of their inventions. Jacob Perkins was born at Newburyport, Mass., in 1766, his ancestors emigrating from Newent, County Gloucester, England, in 1631. Before he was 21 years of age he had shown his inventive genius by the construction of a number of machines. While the colonies were still in the old confederation, Massachusetts had employed Perkins to build minting machinery, the old Massachusetts cent carrying the Indian and Eagle being one of the pieces struck by Perkins. Later, when but 24 years old, he built a nail-cutting and heading machine, his title to which was sustained by a seven-year law suit. The machine was first erected at Newburyport but later was moved to Amesbury, where he built a waterwheel on the Merrimac River.

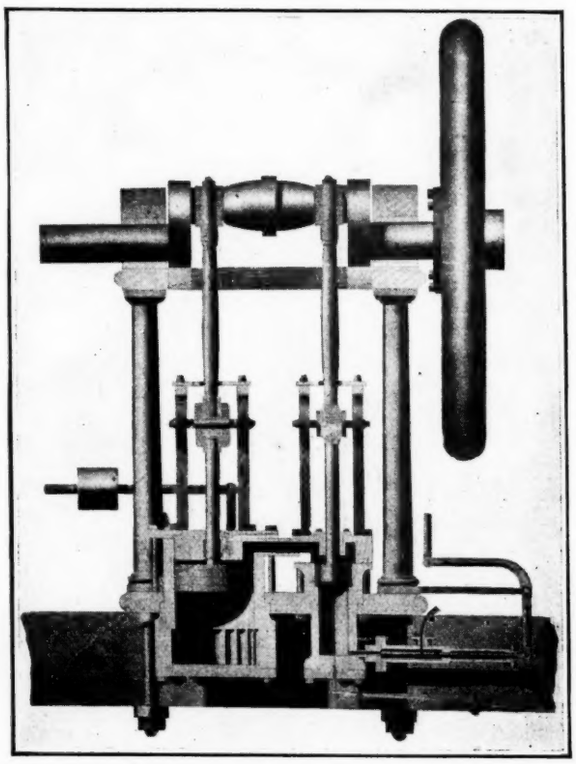
Perkins was most versatile in his talents and extended his activities into numerous fields. Among other devices he invented the stereotype check-plate used in printing bank notes, through which counterfeiting was practically impossible. In 1818 he emigrated to England and in the following year attempted to interest the Bank of England in his bank-note process, but without avail. Nevertheless, it was not long before the bank made use of the Perkins process with some minor modification, but without any recognition of his claims. In the end the private banks adopted the bank note, Perkins selling them an interest in his patent.

His interest now went far afield, as evidenced by his communications to the Society of Arts concerning his improvements in the warming and heating of dwellings and his new method of making the seams of the leather fire hose. He also called the society's attention to his ship pump as well as to improvements he had made in waterwheels. Several gold medals were presented by the society as evidences of its appreciation of his engineer efforts.

In 1824 he turned his attention to steam and developed a gun using steam at 1,500 lb. per sq.in. as the propelling agent. The Ordnance Committee under the Duke of Wellington reported that the steam was equal to the best gunpowder as far as the bullet velocity was concerned. The French government seized upon the idea, but as Perkins was too ill to attend, the tests were not successful.

The steam boilers of that day were hammered-plate pots whose very crudeness of construction prohibited the use of steam pressures of much over 5 lb. gage per sq.in. In fact, the advantages obtained by working high-pressure steam through a number of expansions were not understood, James Watt vehemently opposing even 25 lb. as dangerous. Perkins, against the opposition of Watt and other engineers, boldly advocated the use of pressures of from 1,000 to 3,000 lb. gage and superheats of 400 to 500 deg.; the outcome of his studies was the patenting of a high-pressure boiler, which in principle has been reintroduced in modern engineering circles.

In 1837 he contributed a paper to the Institution of Civil Engineers on the subject of superheated steam for locomotives, emphasizing the fact that the highly heated steam could lose considerable heat without becoming wet. It will be seen that Hirn's discovery of the advantages of superheated steam in 1850 was antedated by some years. Still another suggestion offered by the ingenious inventor was the mass production of locomotive parts in jigs.



Compound unaflow engine invented by Jacob Perkins

He met with the disappointments to be expected by a man eighty to ninety years in advance of his time. These at least induced him to retire some fifteen years

before his death, which occurred in 1849. His tomb may be found in Kensal-Green Cemetery, West London.

The inventive genius of the father was inherited by the son, Angier March Perkins, born at Newburyport, Mass. He emigrated to England in 1827 and there brought out a steel-engraving process, as well as the first adhesive stamp used by the Postal Union.

Following his father's footsteps, he turned his attention to high-pressure steam, going so far as to invent an iron-smelting process in which superheated steam was employed. Among other patents was the one covering the right-and-left-hand screw for jacks. He died April 22, 1881, at the age of 81 years.

The third generation was well represented by Loftus Perkins, who was born at London in 1834, but who always considered himself an American. His most important work in engineering was his inventions of high-pressure machinery. Even as early as 1859 he had designed an engine to work under 600 lb. pressure. He built the yacht "Anthracite," using a triple-expansion engine in which the steam by reheating was kept in the superheated state in all the cylinders. The boiler was of a special water-tube design, and the combined unit delivered a shaft horsepower at the expense of 1¼ lb. of coal. The world was not prepared for such pressures and temperatures, consequently, even though tests by United States Navy officials substantiated Perkins' claims, the idea was allow to languish. Among other inventions was a steam automobile, a water meter, a ventilating system and metal carriage wheels. He died April 27, 1891.

A son, Loftus P. Perkins, did not follow the family's bent of high-pressure steam, but entered the manufacturing of steam baking ovens and is at present engaged in this work in London, thus representing the fourth generation of a family of engineers.

The Development of Perkins' Idea

PROBABLY no other phase of civilization has shown so much advance in the last 100 years as has engineering, and there is no doubt that if John Seaton or James Watt awakened today, they would be amazed at the absence of the old haystack boiler and atmospheric-pressure engine. On the other hand, picture the satisfaction of Jacob Perkins in finding power plants making use of the unaflow engine he patented, even though the modern engineer be still a bit fearful of employing the 1,000 to 3,000 lb. steam pressure Perkins advocated and used, and still experimenting with his compound unaflow.

Since high pressures such as Jacob Perkins advocated, could not be employed in the engines then in existence, Perkins disregarded all the tranditions of engine building to produce a machine that not only is the direct progenitor of the modern unaflow, but incorporates certain ideas as to the condenser that offer attractions even though not yet adopted.

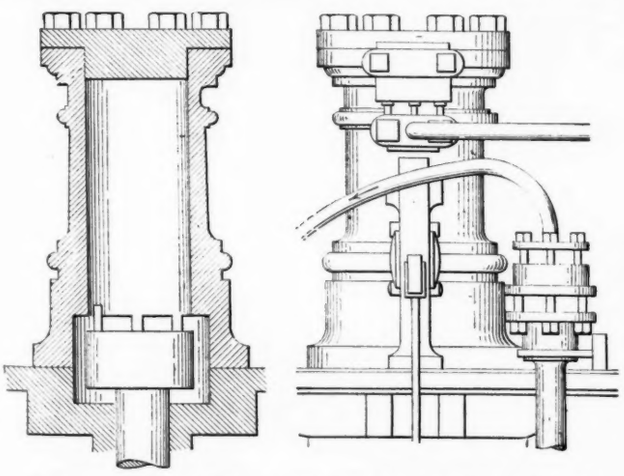


Fig. 1—The Perkins single-acting unaflow of 1820

The engine, as patented in 1827, consisted of a single-acting cylinder in which the piston overran the exhaust ports. This design was substantially that later patented by Todd and, with the addition of steam jacketing, by Stumpf. In order to enable his engine to operate with a variable back pressure, Perkins' patent states that "should any water remain uncondensed in the cylinder after the piston passes the perforations in its ascent, it (the steam) will pass through the valve which is opened by the piston coming in contact with the cap of the cylinder in which the perforations are made and be perfectly condensed before the steam is again admitted to the cylinder." This valve is obviously a bypass valve in the piston. By having a correct clearance volume the late closing of this bypass valve would bring the compression up to the initial pressure. In view of the slow speed then employed, it is probable that Perkins contemplated no attempt to obtain compression; while he would have lost whatever economy high compression might give, he would have gained a fatter work or indicator diagram. Since the engine was to work with a pressure of 1,400 lb. per sq.in. and 1,000 deg. temperature, the heat interchange with the walls would not be great and the use of the Perkins auxiliary exhaust valves was of advantage.

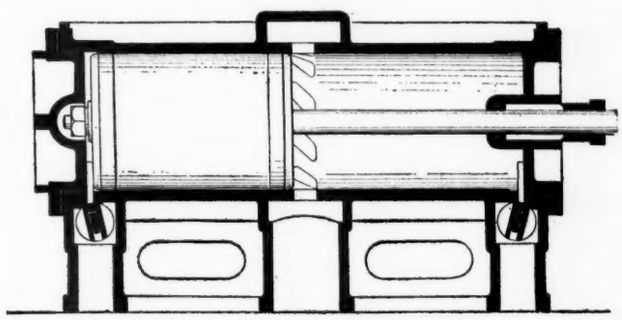


Fig. 2—The Todd engine of 1885

The inventor embodied in his patent claims another idea that deserves mention as promising merit even though up to the present no one has adopted the idea. In place of having a condenser large enough to condense all the steam passing out of the cylinder, Perkins outlined an arrangement whereby the cylinder steam at release should blow through the condenser and out of a relief valve to the atmosphere. As soon as the pressure reached atmosphere (it should be remembered that the drop between release and atmospheric pressure represents the discharge of most of the cylinder steam),

the relief valve closed and the condensing water jets opened. The resulting condensation brought the cylinder pressure down to the desired vacuum. On the next exhaust the condensed steam and the condensing water resting above the relief valve were thrown down through the discharge tube into the hotwell.

Perkins Patents Compound Unaflow

Not content with a single-cylinder unaflow, Perkins, probably being familiar with the advantages shown by Hornblower's compound over the Watts single-cylinder engine, made claims for a patent on a compound unaflow, the patent drawing of which appears on page 718, and a cross-section in Fig. 4.

This engine was a single-acting two-cylinder compound, the object being, as stated in the patent specifications, "to take the utmost advantage of the expansive property of steam, thereby producing much greater economy in the fuel." Steam was to be admitted through a small induction (admission) valve at the intake end of the high-pressure cylinder at a pressure of 100 atmospheres (1,470 lb.) and cutoff was to occur at one-eighth stroke. When the high-pressure piston uncovered the exhaust ports, the steam would pass through a connecting pipe or receiver into the low-pressure cylinder. After doing work in this cylinder, the steam was to escape through the ports uncovered by the low-pressure piston. The condenser was to have the same devices for atmosphere relief and jet condensation as fitted to the single-cylinder unaflow. Both high- and low-pressure pistons, as shown in Fig. 4, were provided with bypass or auxiliary relief valves in the piston. The advantage of the bypass valve lies in the relief of back pressure in the high-pressure piston, so that the pressures in the two sides being equalized, the negative work on the return stroke would be a minimum, and in addition give a fat indicator diagram. The idea of a piston-contained auxiliary exhaust valve has been revived at numerous times. Professor Stumpf, in the first edition of his book on unaflow engines, gives considerable detail as to how these valves could be incorporated in a unaflow engine and actuated by a rod

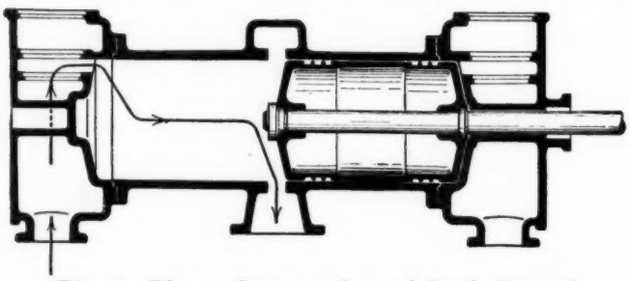


Fig. 3—The modern unaflow of Prof. Stumpf

to the crosshead end of the connecting rod. Certainly, it appears to possess marked thermal advantages over the usual auxiliary exhaust valve placed within or close to the steam-jacketed cylinder head.

The single-beat admission valve may seem decidedly modern since the unaflow engine builders are now experimenting with this type of valve. The cutoff was varied through the adjusting of a turnbuckle on the valve end, a leaf spring being used to close the valve.

At first glance Perkins' compound seems unworkable since the high-pressure piston seemingly uncovers the ports before the low-pressure reaches the end of its stroke. The inventor anticipated this by specifying in his claims that the cranks were to be set at slightly less than 360 deg., permitting the low-pressure piston to have reached upper dead center before the high-pressure piston uncovered the high-pressure ports.

The Perkins unaflow met with no commercial success, and nothing beyond the patent grants was heard of

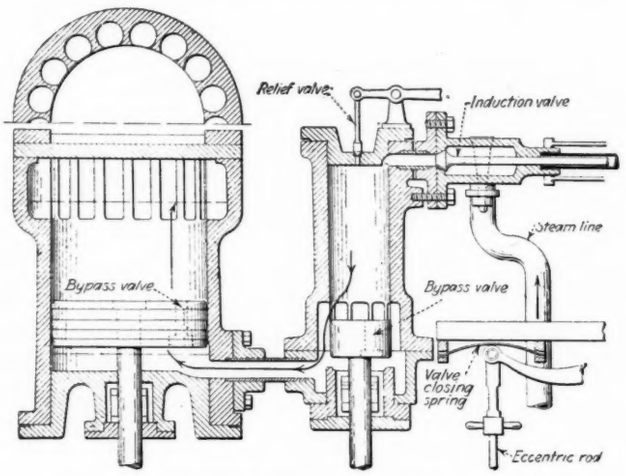


Fig. 4—Compound unaflow patented by Perkins

until L. J. Todd was granted an English patent in 1885 for a double-acting unaflow engine which was, in effect, the casting of two Perkins cylinders in one piece to make a double-acting machine with the exhaust in the center. Todd evidently did not believe that steam jacketing of the heads was of much advantage, so insulating material was used, as shown in Fig. 2. While a number of engines using this type of piston were put in service under the trade name, "Cleveland cylinders," the engine lost what little prominence it had until Professor Stumpf obtained a German and other patents for an engine in which the Perkins unadirectional flow of steam was followed, but improved upon by the use of steam-jacketed cylinder heads, as indicated in Fig. 3.

Jacketing Unaflow Engine Heads

The jacketing of engine heads is by no means novel, but used in combination with the unaflow principle it was the basis of the modern unaflow patents, although all unaflows are not so jacketed; as example, the 25,000-hp. Nordberg unaflows installed in a steel mill are jacketless. While it is generally assumed that the single-cylinder unaflow was as economical as an engine where the expansion was carried on in two or more cylinders, of late there has been much development work on a compound engine having a counterflow high-pressure and a unaflow low-pressure cylinder. It is claimed by the builders that the slight advantage to be obtained by using a unaflow high-pressure cylinder is more than offset by the mechanical complication. This engine, using steam at 900 lb. pressure, has shown an economy unapproached by any steam turbine.

It is but natural to presume that the next new idea in engine construction will be the true unaflow compound machine.

It is unfortunate that Perkins lived in an age when the art of machine building was so crude and the price of fuel and labor so low, that his ideas of high-economy engines could not have been placed in practice.

Changing a Series Motor to Shunt or a Shunt to a Series

By A. C. ROE
Repair Superintendent, Detroit Service Station, Westinghouse Electric & Manufacturing Company

IN A series motor the speed varies with the load, but the speed will remain constant for any given load. In a shunt motor operating on constant voltage, the field strength is practically constant. As the load is applied, the armature takes more current to produce sufficient torque to carry the load. This increase in current increases the armature reaction, which tends to weaken the field and increase the speed; but the counter-electromotive force in the armature winding must be lower to allow the proper current to flow, so that the net result of an applied load is generally a reduction in speed. The speed decrease of a normal shunt motor amounts to 5 to 7½ per cent from no load to full load, the falling off in speed being greater the higher the armature resistance.

With an accumulatively compound-wound motor the series coils increase the starting torque and the shunt coils tend to hold the speed constant. This fact can be used to advantage when adapting a shunt motor to a load that requires a high starting torque; a number of turns of heavy wire can be added on each field pole and connected in series with the armature.

Changing Series Motor to Shunt

Consider the problem of converting a series motor into a shunt-wound machine without changing the speed, voltage or horsepower. Assume the motor to be rated at 10 hp. 220 volts 1,000 r.p.m. 41 amperes 4 poles. The series-field coils consist of 88 turns of one $\frac{1}{32}$x$\frac{3}{4}$-in. copper strap wound flat in two layers 44 turns per layer, the completed coil being 2 in. high, by $1\frac{5}{8}$ in. deep. The armature is wave wound, has 33 slots, 99 commutator bars, each coil consisting of three turns of two No. 15 d.-c.-c. wires in parallel, coil pitch 1 and 8, lead pitch 1 and 51. To keep the speed, voltage and horsepower constant requires that the field strength remain the same, therefore, the ampere turns per pole must in both cases be equal to $41 \times 88 = 3{,}608$. Now what are required are four shunt-field coils of correct resistance that can be put across a 220-volt line and provide the necessary ampere-turns without overheating the coils. For the shunt coils the size of wire in circ.mils is determined first, then the number of turns is computed. The size of wire, $S = (IT \times M) \div e$, where IT equals the ampere turns per pole, M the mean or average length of one turn in inches, and e the voltage across one coil.

Fig. 1 gives the dimensions of the series coils, and the mean length of one turn may be found by the formula $M = [4(D + D') + 2R\pi] \div 2$. For the radius R the thickness of the coil may be used, when the inside of the coil is practically square as in this case. Then $M = [4(6\frac{1}{2} + 5\frac{3}{4}) + (2 \times 1\frac{5}{8} \times 3.1416)] \div 2 = 29.6$, or approximately 30 inches. The voltage e per coil equals the line voltage E divided by the number of poles, in the problem, $220 \div 4 = 55$ volts. The ampere turns IT per coil = 3,608; then the wire size $S = (3{,}608 \times 30) \div 55 = 1{,}970$ circ.mils. This gives a No. 17 wire as the correct size, which has an area of 2,048 circ.mils. Allowing from 1,200 to 1,500 circ.mils per ampere for a shunt coil will be a safe value in this case. If 1,250 circ.mils per ampere is used, then as the area of wire is 2,048, the permissible current is $2{,}048 \div 1{,}250 = 1.64$ amperes, and the turns per coil equal ampere turns ÷ amperes, or $3{,}608 \div 1.64 = 2{,}200$. In each coil 2,200 turns of No. 17 single-cotton or enameled-covered wires can be used. However, on account of the shunt coils turns requiring somewhat more space than the series coils did, it will probably be found best to use enamel-covered wire.

A No. 17 enamel-covered wire has an outside diameter of 0.0472 in. The coils are two inches wide, so that $2 \div 0.0472 = 42$ turns per layer can be used. Since there are 2,200 turns per coil, there will be

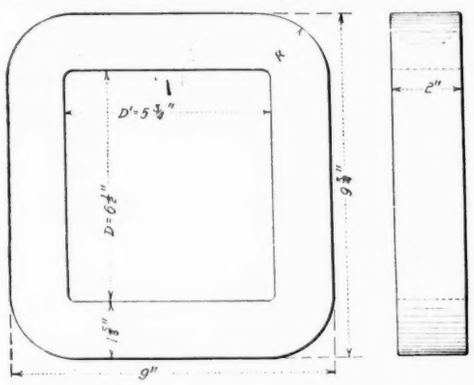


Fig. 1—Dimensions of series coils to be changed to shunt

$2{,}200 \div 42 = 52$ layers. This will make the coil $0.0472 \times 52 = 2.45$ in. thick. However, on account of the turns of one layer bedding down between the turns of the under layer, the dimension will probably be less than the value obtained, but this will depend upon the care used in winding the coils. Assuming that the coil is 2.45 in. thick, then the length of the mean turn is $M = [4(6\frac{1}{2} + 5\frac{3}{4}) + 2 \times 2.45 \times 3.1416] \div 2 = 32.2$ in. In the four coils there is a total length of wire equal to $2{,}200 \times 4 \times 32.2 \div 12 = 23{,}600$ ft. The resistance of the coils will vary with the temperature, but taking it at an average temperature of 122 deg. F., a No. 17 wire has 5.648 ohms per 1,000 ft. Then the four coils will have a total resistance of $5.648 \times 23{,}600 \div 1{,}000 = 133$ ohms. The current taken by the coil equals volts divided by ohms $= 220 \div 133 = 1.65$, which checks closely enough with the field current (1.64 amperes) on which the turns in the coils were based, for all practical purposes.

Another feature that should be considered is the heat that must be dissipated from the coil. The energy expended in the coils that must be radiated as heat is equal to the watts, or in this case $220 \times 1.64 = 360.8$. For field coils in open-type machines the watts that can

safely be radiated from the outside cylindrical surface of the coil vary from 0.75 to about 1.5, depending upon the speed and ventilation of the machine and the size of the coil. In this problem the circumference of a coil is equal to $C = 2(D + D') + 2\pi R$. Since the coil is 2.45 in. thick, this value will be used for R, then $C = 2(6\frac{1}{2} + 5\frac{3}{4}) + 2 \times 3.1416 \times 2.45 = 40$ in. Since the coils are 2 in. wide, the area of their cylindrical surfaces equals $40 \times 2 \times 4 = 320$ sq.in. This allows $360.8 \div 320 = 1.12$ watts per square inch that must be radiated, which is a safe value considering that the coils are of comparatively small cross-section and, being wound with enamel-covered wire, will have fairly good heat-conducting qualities.

The armature circuit need not be changed, as the field flux is to remain the same as for the series machine and the speed and voltage are not to be changed. As the armature is now to be connected directly across the line, with the same full-load current, the speed is

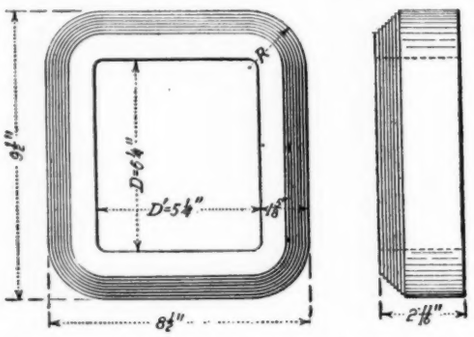


Fig. 2—Dimensions of shunt coils to be changed to series

likely to vary slightly from that for the series motor, since in one case the series winding is in series with the armature and in the other case it is not, but this will not be great enough to cause any trouble.

Consider converting a shunt motor to a series-wound type without altering the speed, voltage or horsepower. This motor has a rating of 10 hp. 220 volts 41 amperes 1,250 r.p.m. 4 poles, each shunt coil consisting of 2,118 turns of one No. 19 s.-c.-c. wire, in 36 layers—22 layers of 62 turns each, 2 of 60 turns, 2 of 58 turns, 2 of 56 turns, 2 of 54 turns, 2 of 52 turns, 2 of 50 turns, 2 of 47 turns. These coil dimensions are shown in Fig. 2. The first step is to determine the number of ampere turns per pole. One method is to apply rated voltage to the field coils with an ammeter in the circuit to find the current flowing. This should be a low reading instrument so that the current can be accurately determined. The turns per coil are multiplied by the current so found to obtain ampere turns. Another method is to transpose the formula for finding the size of wire for a shunt coil, to read $IT = \frac{eS}{M}$, for finding the ampere turns required. In this problem from Fig. 2, $M = [4(6\frac{1}{4} + 5\frac{1}{4}) + 2 \times 3.1416 \times 1.\frac{5}{8}] = 28$. One No. 19 wire has an area of 1,288 circ.mils, therefore $IT = \frac{55 \times 1,288}{28} = 2,530$ ampere turns per pole approximately. The current in the shunt-field circuit is $\frac{IT}{T} = \frac{2,530}{2,118} = 1.2$ amperes, or approximately 3 per cent of the total line current. With 2,530 ampere turns required per pole and a line current of 41 amperes, the turns required for a series coil will be $2,530 \div 41 = 62$ turns per coil. Allowing 1,100 circ.mils per ampere, the size of wire equals $41 \times 1,100 = 45,100$ circ.mils. The nearest size is a No. 4 round wire with an area of 41,740 circ.mils. This gives $41.740 \div 41 = 1,018$ circ.mils per ampere, which will be satisfactory.

The next step is to lay out the turns and layers. The best type of field coil for heat radiating is a thin deep one. Allowing $2\frac{1}{2}$ in. for winding space, and since a No. 4 d.-c.-c. round wire has a diameter of 0.222 in., there will be $2.5 \div 0.222 = 12$ turns per layer. Then with 12 turns per layer there will have to be $62 \div 12 = 5\frac{1}{6}$ layers, or 5 layers of 12 turns and one layer of 2 turns per coil, a total of six layers. This would make the coil $0.222 \times 6 = 1.332$ in. thick, which is slightly under the old dimension. Therefore the four series coils can each have 62 turns of one No. 4 d.-c.-c. wire. The armature would not have to be changed. If either of the two motors in the problems had interpoles, these would not require any change, as they are in series with the armature in all cases. When changing from a shunt interpole motor to a series winding, put the series and commutating coils in series on the same side of the armature, as this lowers the potential between the series and interpole coils by an amount equal to the volts across the armature.

Combustion in an Oil Engine

The process of combustion that takes place in the cylinder of an internal-combustion engine is simply a chemical reaction. In actuality the cylinder is merely a chemist's retort wherein the atoms of hydrogen and carbon that make up the body of the fuel charge, unite with the oxygen contained in the air charge, forming oxides.

The carbon in its union with oxygen forms either carbon monoxide (CO) or carbon dioxide (CC_2). In this latter chemical reaction an atom of carbon unites with two atoms of oxygen forming one molecule of carbon dioxide; this combustion releases 14,600 B.t.u. per pound of carbon and raises the remaining unburnt carbon to the incandescent point. Unless there is sufficient oxygen present, the remaining carbon unites with one of the oxygen atoms of the carbon dioxide molecule, causing the entire carbon oxide to assume the form of carbon monoxide. Since the reaction is incomplete, the heat released by the formation of carbon monoxide from carbon and oxygen is less than that produced by the complete reaction to carbon dioxide. The value is approximately 4,380 B.t.u., making evident the heat loss when the combustion is not complete.

All Diesel cylinders are of ample volume to give sufficient oxygen for complete combustion. If the chemical reaction is not fully carried out, it is due to causes other than an insufficient supply of oxygen. In most instances the defect is traceable to poor atomization, wherein the oil charge is not separated into particles of such minute dimensions that each carbon particle contacts with the required amount of oxygen. If the oil droplets entering the cylinder are of fairly large diameter, the oxygen is in direct contact with only the carbon at the surface of the droplet. The carbon within the droplet must receive its oxygen from the carbon dioxide formed at the surface. For this reason the engine's efficiency depends on the degree of atomization of the fuel charge.

A Gift of Extra Compressor Capacity

Ways of Handling Ammonia at Two Suction Pressures—Advantages of Multi-Effect Compression—Increased Capacity—Reduced Horsepower per Ton

By G. GROW

BEING in charge of a refrigerating plant contemplating the use of two suction pressures, I have been much interested in the idea of using but a single compressor cylinder to handle the two suction gases. Recently, in a discussion at a meeting of refrigerating engineers a well-known member opined that there was nothing to the proposition of this so-called "multi-effect" compression. Taking a piece of paper from his pocket, he rapidly sketched an indicator diagram in heavy outline similar to Fig. 1, marking the suction pressure as being 15 lb. absolute and the discharge 180 lb. Next he added lines such as are shown broken in Fig. 1, and stated that the solid-line diagram

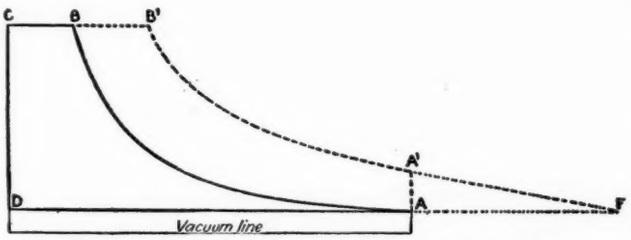


Fig. 1—The engineer illustrates multi-effect compression by this diagram

represented the work and capacity of a compressor working under one suction pressure. By placing a cam-controlled auxiliary valve at the suction connection, gas at, say, 45 lb. could flow into the cylinder after it was filled with the low-pressure gas. The entrance of this suction gas at a high pressure causes the cylinder pressure to rise from 15 to 45 lb. as shown by *AA'*, these being the assumed suction pressures.

"Now," continued the engineer, "the area *AA'B'B* represents the increase in the work of the compressor, while the area of the toe, or *AFA'*, represents the increase in the volume of gas handled by the compressor."

Examining the Process

The apparent agreement of the other engineers with this statement gave me food for thought. Evidently, I was not going to be able to make use of one cylinder to do the work of two save at a decided drop in compressor efficiency. Nevertheless, on going home the idea of multi-effect compression was so attractive that I started to dig into the problem and find out just what were the facts.

Referring again to the sketch made by the engineer, I could see that in one point at least he was wrong. The area of the toe of the diagram did not represent the increase in gas handled nor enter into the problem in any way. In order that engineers who, like myself, so often blindly accept another's pronouncement as to the merits of a process, may fully understand multi-effect compression, the entire process, as I worked it out, will be discussed.

To deal with concrete values, let us assume that one suction pressure is 15 lb. per sq.in. absolute, while the other is 45 lb., the discharge pressure being 180 lb. Let us also imagine that the piston displacement is 2 cu.ft. If only the low-pressure suction is connected to the machine, the indicator diagram will be similar to Fig. 2. In this diagram the length is proportional to the piston displacement, and with a perfect machine this displacement of 2 cu.ft. is also the volume of the 15 lb. suction gas taken in per stroke. The area of the diagram is proportional to the work required to compress the gas to the discharge pressure and force it out of the cylinder. If the gas does not lose some of its heat to the walls or absorb any during the cycle, the work consumed may be calculated from the formula given in Fig. 2. The compressor, for simplicity, is assumed to have no clearance.

Using Two Pressures

Now what happens when the 45-lb. suction line is connected to the machine? The cylinder is filled with gas at 15 lb. pressure, and its conditions of pressure and volume are represented by the point *A* in Fig. 4, but as soon as the auxiliary valve, already alluded to, is opened, the high-pressure suction gas rushes in

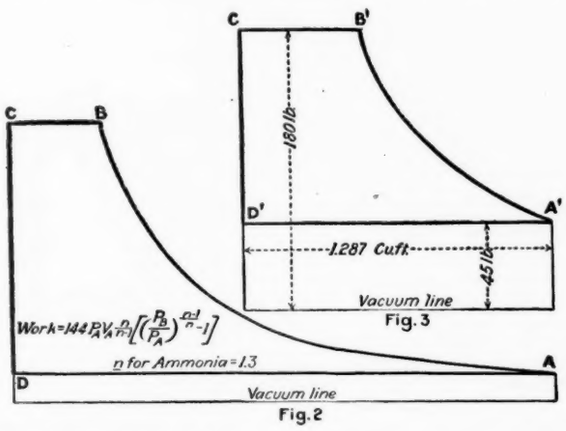


Fig. 2—Diagram when a low-pressure suction gas is handled. Fig. 3—Work diagram when compressing high-pressure gas in separate cylinder

and, mixing with the low-pressure gas, continues to flow in until the cylinder pressure is equal to 45 lb. as indicated by the point *A'*. The volume of gas is still but 2 cu.ft., but while there was only 0.114 lb. (gas at 15 lb. pressure, weighing 0.057 lb. per cu.ft.) we have admitted more gas until the 2 cu.ft. at 45 lb. weighs 0.32 lb. The compression of this gas follows the curve *A'B'*, Fig. 4, the discharge valve opens and the gas is forced

out at 180 lb. pressure, as indicated by the line *B'C*. The completed diagram is *AA'B'CD*.

The question occurs, where is the saving? Before this can be answered, it is necessary to find how many foot-pounds would be required to compress in a second cylinder the high-pressure gas admitted and handled by one compressor. The weight of high-pressure gas entering the cylinder is obviously the difference between the weight of low-pressure gas entering and the amount in the cylinder after the high-pressure suction valve

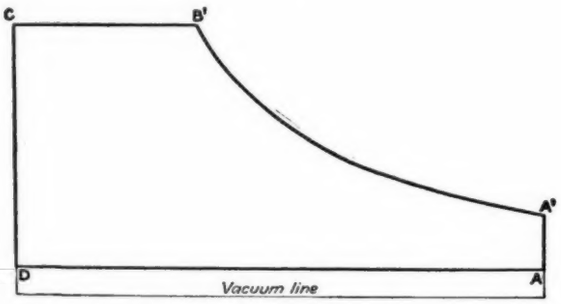


Fig. 4—Compressor handling two pressures gives this diagram

closes at *A'*. The latter has been shown to be 0.32 lb. (0.3196 to be exact), while the former was 0.114 lb. (0.1136 exact), or the high-pressure gas entering amounts to 0.206 lb. If this weight of gas had been handled by a different machine, the displacement would need be 1.287 cu.ft. The indicator diagram would be similar to Fig. 3. By planimetering the areas of the three diagrams, it will be found that the area of Fig. 3 plus the area of Fig. 2 just equals the area of Fig. 4.

Net Saving of Process

We have then used the same power in operating one multi-effect machine when handling amounts of the two suction gases as required if the compressions had taken place in separate machines. But the weight of ammonia handled in a 2-cu.ft. compressor is 0.32 lb., or by the addition of the multi-effect device the capacity by weight has increased from 0.114 lb. to 0.32, and we have avoided the purchase of an extra machine for the high-pressure gas of a capacity of 1.287 cu.ft.

Note, however, that the work done per stroke when handling the two gases is greater than when but one gas is handled. This means that the engine or motor must be large enough to carry this increased load.

But what does this mean in the way of horsepower per ton of refrigeration? On the assumption that the ammonia reaches the expansion valve at 87 deg. temperature (corresponding to 172 lb. pressure, the remaining pressure of 8 lb. being due to foreign gases, the heat picked up per pound of ammonia is the total heat H at 15 lb. minus the heat of the liquid h at 172 lb., or 602 — 140 = 462 B.t.u. A duty of one ton of refrigeration is equivalent to the removal of 200 B.t.u. per min. Since 0.114 lb. is handled per stroke, the B.t.u. removed per stroke is equal to 52 B.t.u., or a duty of 52 ÷ 200 = 0.26 ton.

The total heat in 1 lb. of high-pressure gas is 555.5 B.t.u. Each pound circulated picks up 555.5 — 140 = 415.5 B.t.u., and since 0.206 lb. is circulated per stroke the tonnage = 0.206 × 415.5 ÷ 200 = 0.427 ton. We have then obtained an additional duty of 0.167 ton. It would seem worth while.

Clearance, as is well known, decreases the capacity of a machine. With multi-effect compression the volumetric efficiency of the machine affects only the low-pressure suction-gas capacity; the high-pressure suction-gas volume is not influenced in any way by the re-expansion of the clearance gas, and the actual gain will exceed the calculated by as much as 15 per cent.

There is in the working machine an actual saving in horsepower. The low-suction gas entering the cylinder cools the valves, etc., and the high-pressure gas does not superheat on entering, which means the horsepower per pound of ammonia is decreased. A second saving also exists. Since from 10 to 15 per cent of the power delivered to the compressor is required to overcome friction, the avoidance of the second compressor eliminates about 10 per cent of the additional power requirements.

Oil Conservation for the Navy

In outlining the policy of the President's Commission on Oil Reserves, Dr. George Otis Smith, its chairman, recently issued the following statement:

The naval oil reserves were created with the declared purpose that the government retain ownership of as large tracts of oil lands as could be then found, so as to provide for any future needs of the navy. The original intent, declared in a time of plenty, was to store oil where nature placed it against the time when oil in the quantities then needed could not be had through the ordinary trade channels. This purpose was later reiterated by the General Board of the Navy in its study of national defense by recommending "the purchase of oil for the Navy's needs as long as it is possible to do so, thus deferring the tapping of the Navy's reserve until the last moment."

When the time comes that American industry and commerce are forced to depend in large part upon foreign oil, the American Navy, as well as other arms of national defense, should have its reserves of American oil to fall back upon. Any other policy would endanger national security.

Whatever may be the outcome of litigation now pending, in the prosecution of which the several government agencies are co-operating, the President's Commission intends to base its immediate recommendations for administrative action upon the broad principle of preserving for the Navy as much as possible of the Navy's oil reserves until the Navy's need is most urgent. Many and difficult techncial questions must be studied, relating both to the government's requirements and to the adequacy of present reserves. It is realized also that the oil problem of the future involves far more than the naval needs alone, as the national defense includes provision for war industries, sea-borne transport, and army movements—all the activities, in fact, of a mobilized nation.

During the year 1923 42 explosions occurred in the United Kingdom. These resulted in the killing of ten persons and injury to forty-two others. Eighteen of these explosions, by which four persons were killed and fifteen others injured, may be termed "Boiler explosions proper," while the remaining twenty-four, killing six persons and injuring twenty-seven others, may be termed "Miscellaneous" explosions, that is, those arising from steam pipes, stop valves, kiers, drying cylinders, bakers' ovens, etc.—From Report of Manchester Steam Users' Association.

Carl Gustaff Patrik de Laval was born in Sweden May 9, 1845, and died in his 67th year. His first commercially practical turbine was built in 1883 and drove a cream separator, direct connected. In 1888 the flexible shaft was adopted for high-speed turbines. He also made many inventions in metallurgical processes.

Power Requirements in New England

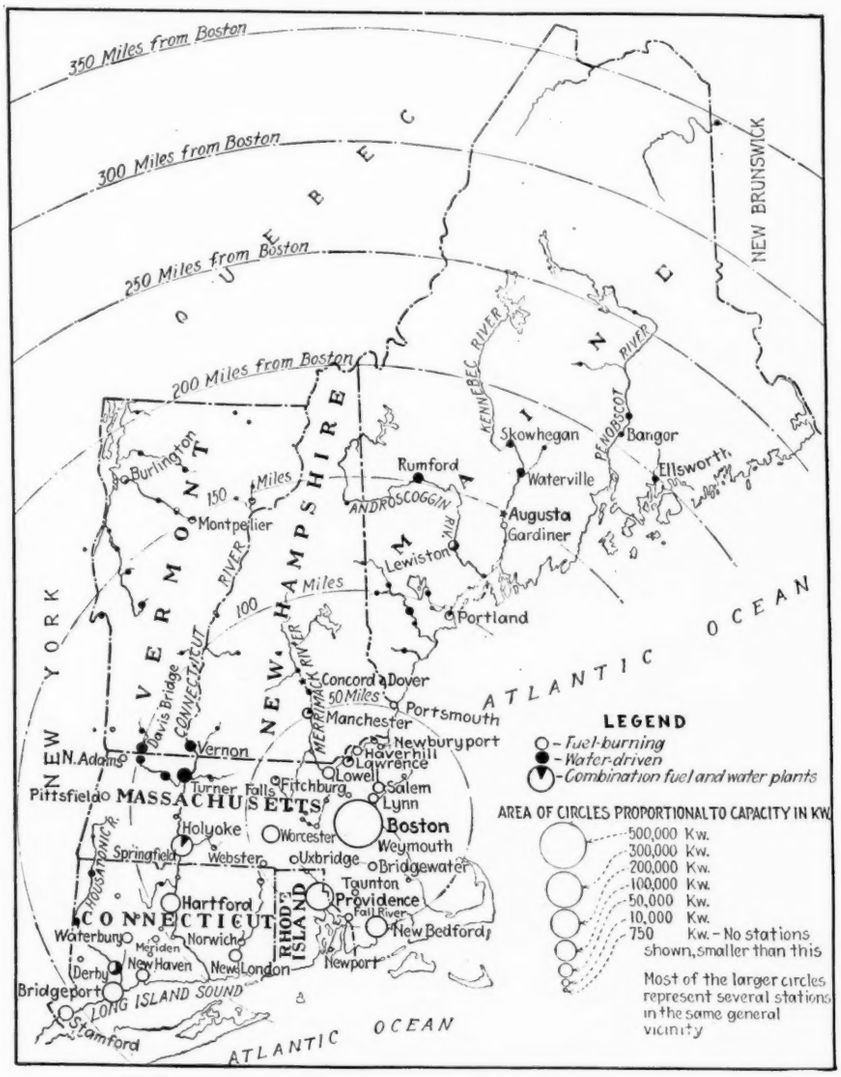
Power-Investigating Committee Finds that 1,400,000 Kw. Will Be Required Within Ten Years to Meet Increased Demands

IN MARCH, 1923, a committee was appointed by the Associated Industries of Massachusetts to ascertain the facts with reference to the present power situation in New England—the kind and amounts of present sources of power, the cost of each and the increase in cost in the last ten years; the available new sources of power both within and without the New England States, the probable demand for such power and the cost of supplying it to the industries and public utilities of Massachusetts. This committee consisted of Charles T. Main, consulting engineer, Boston; Henry I. Harriman, president of the New England Power Co.; Dugal C. Jackson, of the Massachusetts Institute of Technology; George L. Finch, consulting engineer, Boston; and B. Preston Clark, vice-president, Plymouth Cordage Co., Boston. This committee has recently completed its investigation and submitted a report, which consists of 183 pages. From the data obtained and analyzed the following conclusions have been presented by the committee to the Associated Industries.

The industries of Massachusetts required in 1922 for their load of about 1,250,000 hp., of which 515,000 hp. was used in the textile and 735,000 hp. in all other industries, a total installed capacity of about 1,800,000 hp. Of this about 300,000 hp. was steam-generating capacity in industries which required considerable steam for process work as well as for power. Figures are not available for all of New England, but the indications are that the total power required was 2,650,000 horsepower.

The total energy used in New England in 1922 (except in steam locomotives) was about 7,500,000,000 kw.-hr., of which about one-half was generated by the industries themselves and one-half by the public utilities. Of this total about 2,200,000,000 kw.-hr., was generated by water power. In Massachusetts, New Hampshire and Rhode Island the power systems are already interconnected in such a manner as to make it advisable to treat the power required for this area as a group centering around eastern Massachusetts rather than to consider Massachusetts alone. The energy used in 1922 in this district was about 4,900,000,000 kw.-hr., of which the public utilities produced about one-half. Of the total about 1,000,000,000 kw.-hr. was produced by water power and the remainder from fuel. Judging from the past, the indications are that the total power requirements for New England ten years hence will be at least 15 per cent and possibly 20 per cent more than they are now. The same relative increase will hold for Massachusetts alone. The rate of increase of the loads on the central stations is greater than the rate of increase of the total power demands, thus showing that the public utliities are taking over a portion of the load, the power for which was formerly generated by industries. As existing steam plants wear out, they will continue to be replaced by power purchased from public utilities, especially in those industries that do not have important uses for exhaust steam.

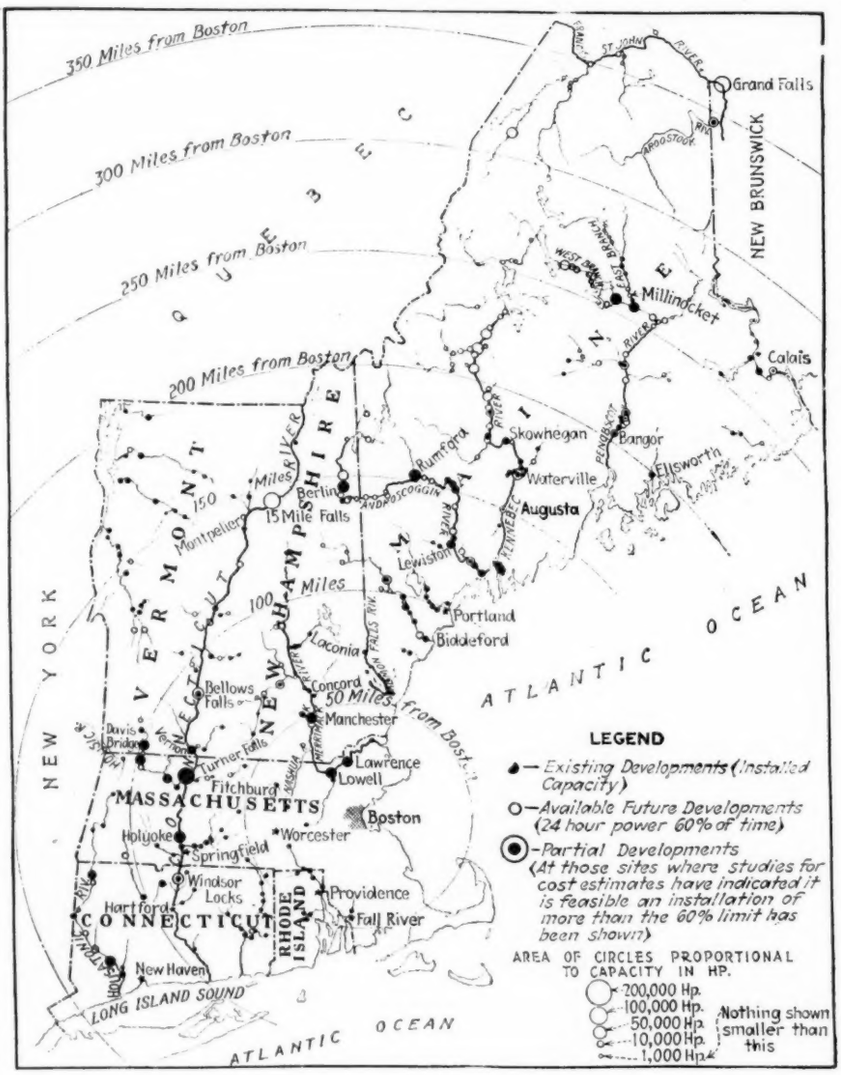
It is expected that on an average for the next ten years the load on the public utilities will increase each



Capacity of central power stations in New England

year by the following amounts, which may be regarded as a conservative estimate: For the Massachusetts, New Hampshire and Rhode Island group centering around eastern Massachusetts, 90,000-kw. net additional capacity will be required and 190,000,000-kw.-hr. generated; for all New England 140,000 kw. and 300,000,000 kilowatt-hours. This would mean that during the next ten years approximately 1,400,000 kw. of central-station capacity must be added to that already existing in New England, exclusive of replacements.

To electrify the additional railroad trackage on which electrification would be desirable in the near future, would require about another 1,000,000 kw. of station capacity and 2,000,000,000 kw.-hr. per year after the electrification is accomplished. Such electrification of the railroads will depend upon their financial condition. With regard to where the necessary increase in power can be obtained at reasonable costs, the committee points out that there is undeveloped water power in New England at sites where 1,000 hp. or more is available for 60 per cent of the time, about 860,000 hp., or 640,000 kw. If it could all be fully developed for 50 per cent load factor, this would require a station capacity of 1,720,000 hp., or 1,280,000 kw., and would produce about 4,830,000,000 kw.-hr. This would be sufficient to take care of the requirements for several years not considering the electrification of railroads, but unfortunately, about three-quarters of this undeveloped power is in Maine and, under the existing laws, cannot be exported. There remains in the rest of New England about 160,000 kw., equivalent to about 1,200,000,000 kw.-hr. Most of this power will not be developed in the near future because of the high cost of development and of delivered current.



Developed and undeveloped water power in New England

railroads, and the power plant and structures, that is, up to the outgoing lines. These costs of the development of the water-power plants would be less than $100 per horsepower for about 45 per cent of the total available power, and between $100 and $150 per horsepower for an additional 25 per cent of the total.

It appears that in all New England, including Maine, enough could be developed at reasonable cost to produce about 3,000,000,000 kw.-hr., of which only a small portion is in the Massachusetts, New Hampshire and Rhode Island district. The remainder, requiring interstate transportation, is not available, in the absence of legislation or Supreme Court ruling, declaring electric power to be a lawful article of commerce. Some additional water power can be obtained from the small undeveloped powers, and used either locally or as feeders to larger systems. Some additional surplus power can be supplied at Lawrence, Holyoke and Turners Falls. A greater amount of power can be obtained from some existing properties by redeveloping and getting greater efficiency and capacity. The total from all such sources is relatively small compared with the total power requirements for New England's growth, although important to individual plants. In view of the foregoing, it is the opinion of the committee that the great bulk of the power for New England's additional requirements, particularly in the district centering about eastern Massachusetts, must come from:

1. Large public-service steam plants, located not far from the load centers and so as to obtain coal at the lowest rates, and containing large units and interconnected so as to run on high load factors at minimum operating cost.

2. Suplementing of such steam plants in New England by large water powers in Canada, if proper agreements can be made for the export of electric current.

There are two potential sources of such water power—the large developments on the tributaries of the St. Lawrence in Quebec, in the early construction of which private capital is already engaged and which can be economically developed in progressive steps, and the still larger developments on the St. Lawrence, which undoubtedly must wait for the international canalization of the river.

Broadly considered, the development of water powers as fast as the load is created to absorb their output is highly desirable as a measure of conservation of irreplaceable fuel resources. Nevertheless, they must be justified economically before they can attract the necessary capital.

Taking a broad view of the demands that will be made in the near future upon every available resource for transportation and power, it is merely a question of time when the St. Lawrence canal will be constructed. It is possible that permanent power from this source may be available for New England by 1935 or 1940.

In the meantime it is to the mutual advantage of New England and Quebec to promote for their joint use the early development of some of the water powers on the tributaries of the St. Lawrence. The crowded industrial centers in southern New England need this water power which now runs to waste, and the domestic plants and paper industries of Quebec look to this side of the border for their essential coal, the cost and difficulty of securing which is continually increasing.

Industry Cannot Be Freed from Coal Supply

The inference should not be drawn from comparisons of cost that have been made, it is stated in the report, that it is possible for water power to free the industries from their dependence upon a supply of coal; it can merely prevent the cost of power from mounting to continually higher levels, and it can lessen the hazard due to interruptions of the coal supply. If such water power were to be imported in competition with (instead of supplementary to) any and all steam power, its load factor would be reduced and its cost increased above that shown in the estimates.

It is pointed out that the hourly load requirements of industries are so variable that, even when tied together in large power systems, the annual peak load is two and one-half times the average load. Water power from a distant source will best serve New England by being transmitted at as uniform a rate as possible—that is, on a high load factor—and delivering as much surplus power as can be absorbed by the shutting down of steam-driven units while water is wasting over the dams. Hence, such imported water power will be used to supplement the steam power, and one of the principal uses of the near-by steam plants will be to take the load peaks in regular and stand-by service. Very few steam-driven units will be run at night with these large supplementary water powers available. The steam load factor, or hours of operation, is bound to be less and the water load factor more than for the average power demand. Both the size and character of New England's load requirements will continue to demand fuel to burn for a large part of the load. It is to be expected that the interconnection of large water-power and steam plants will result in dismantling only the smaller and less efficient steam plants. Finally, central-station power, distributed by large interconnected systems, is the logical source of supply for over three-quarters of the growing industrial load. The cost of this power can be kept from steadily increasing only by the early importation of water power capable of relieving fuel-burning stations of a large share of the base load.

Cost of Power in Fuel-Burning Plants

According to the report the cost of power on the switchboard in 1923 in textile mills operating 2,400 hr. a year with coal and oil is about as follows:

Size of Plant, Kilowatts	Cost Per Kw.-Hr. in Cents—Coal at $8 at short ton	Oil at $1.80 a bbl.
1,000	2.84	2.56
2,000	2.41	2.13
3,000	2.26	2.00
5,000	2.01	1.92
10,000	1.67	1.58

For each dollar change in cost of coal per ton, there would be a change of 0.15c. per kw-hr. for a 1,000-kw. plant to 0.10c. for a 10,000-kw. plant.

In woolen and worsted mills, where all the exhaust steam and overflow from the condenser are used in manufacturing processes, the net cost would be about as follows:

Size of Plant, Kilowatts	Cost per Kw.-Hr. Cents
500	1.35
1,000	1.20
1,500	1.05
2,000	0.95
3,000	0.87

The paper industry in Massachusetts is one of the large users of power. These mills run twenty-four hours a day, six days a week. The cost of power in paper mills is about as follows:

Size of Plant, Kilowatts	Cost per Kw.-Hr. Cents
1,000	1.84
2,000	1.64
3,000	1.48
5,000	1.34
10,000	1.13

The costs given show that plain cotton-goods mills should be a fruitful field for sale of power in large blocks at reasonable rates, that the woolen industry can make its own power at costs which are not attractive to the public-service corporation, and that a considerable portion of the requirements for paper mills could be sold at rates commensurate with the high load factor conditions.

The availability of the other industries as a market for sale of power depends on two factors: (1) The size and character of the power load, and (2) the possibility of making use of the waste heat of the power plant.

Analysis has been made of the cost of steam-electric power in the important fuel-burning central stations in New England, as reported to the public-utilities commissions. In 1922 the average production cost, not including fixed charges, was 0.95c. per kw.-hr. generated, and the average price to the consumer, which includes fixed charges, distribution costs and losses, and profit, 3.54c. per kw-hr. The cost to consumers of large amounts is much smaller, and to consumers of small amounts is larger than the average.

The load factor has an important bearing on the cost and price. The ratio in large New England central stations of the average to maximum load is about 40 per cent. The ratio of average load to installed capacity is about 25 per cent.

Published rates for sale of power only, to the industries which are, in most cases, located near the central

power stations, are as follows, based on a load similar to the textile industry:

Demand in Kilowatts	Net Rates per Kw.-Hr., Cents
500	1.69 to 2.46
1,000	1.69 to 2.45
2,000	1.40 to 1.90
3,000	1.35 to 1.90
5,000	1.29 to 1.73
10,000	1.20 to 1.69

For stations of 100,000 kw. rated capacity, operating with 35 per cent load factor and with coal at $6.25 a short ton, the cost, including fixed charges, would be about 11¼ mills per kilowatt-hour at the switchboard. Before the current can be delivered to the customers, there must be added the cost of distribution and profit. This is a figure that is difficult to determine as applicable to this particular service of large industrial users, but it would seem that power from such large and efficient stations could be sold in large blocks to conveniently located industries for about 1.50c. per kw. hr. The rate, of course, will vary with the amount taken.

In the case of industries located at a distance from tide-water stations, the cost of electric transmission must be added. It is predicted and expected that proposed large tide-water plants will operate with an average cost of about 2.8 mills per kilowatt-hour less than the better stations in New England today.

Power possibilities in Canada on the St. Lawrence and tributary rivers

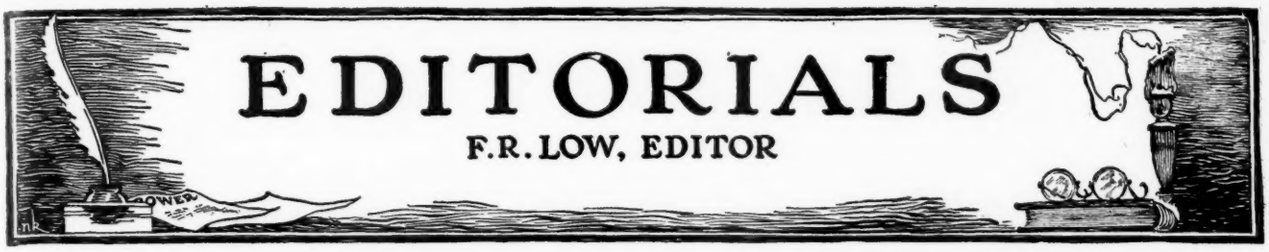
1. 290,000 hp. available (580,000 at 50 per cent load factor).
2. 30,000 hp. available (60,000 at 50 per cent load factor).
3. 60,000 hp. available (120,000 at 50 per cent load factor).
4. 300,000 hp. developed.
5. 75,000 hp. developed at three sites on the three tributaries.
6. 600,000 hp. available (1,200,000 hp. at 50 per cent load factor).
7. 24,000 hp. developed.
8. 8,000 hp. developed.
9. 60,000 hp. available (120,000 at 50 per cent load factor).
10. 17,500 hp. developed.
11. 3,700 hp. developed.
12. 4,000 hp. developed.
13. 8,800 hp. developed.
14. 4,700 hp. developed at two sites.
15. 24,800 hp. developed.
16. 76,000 hp. available (152,000 at 50 per cent load factor).
17. 206,000 hp. available (412,000 at 50 per cent load factor.
18. 162,000 available (324,000 at 50 per cent load factor).
19. 527,000 hp. developed at three sites.
20. 1,000,000 hp. available as part of St. Lawrence canal project.
21. 1,900,000 hp. available as part of St. Lawrence canal project (would wipe out existing development of 245,000 hp., leaving 1,655,000 hp.).
22. 2,000,000 hp. available on international boundary as part of St. Lawrence canal project.
23. 245,000 hp. developed.
24. 220,000 hp. available (440,000 at 50 per cent load factor).
25. 65,000 hp. available (130,000 at 50 per cent load factor).
26. 100,000 hp. available (200,000 at 50 per cent load factor).
27. 80,000 hp. developed.
28. 120,000 hp. available (240,000 at 50 per cent load factor).
29. 120,000 hp. available (240,000 at 50 per cent load factor).
31. 64,000 hp. available (128,000 at 50 per cent load factor).
32. 84,000 hp. available (168,000 at 50 per cent load factor).
33. 28,000 hp. available (56,000 at 50 per cent load factor).
34. 200,000 hp. available (400,000 at 50 per cent load factor).
35. 70,000 hp. total fuel-burning installations in Vermont.
36. 210,000 hp. total fuel-burning installations in Maine.
37. 2,915,000 hp. total fuel-burning installations in Massachusetts, New Hampshire and Rhode Island.
38. 825,000 hp. total fuel-burning installations in Connecticut.

Discussion of the Report

Outstanding features of the New England power resources report were presented April 29 at a joint meeting of the Affiliated Technical Societies of Boston and the Associated Industries of Massachusetts. The speakers were Chairman Charles T. Main of the power investigating committee, Henry I. Harriman, president New England Power Co., and Prof. Dugald C. Jackson, of the Massachusetts Institute of Technology, associate members.

Supplementing the report, Mr. Harriman announced that an investigation is now in progress to determine the economies of interconnection for six leading New England utilities. Preliminary studies indicate that at least 300,000 kilowatts spare capacity can be utilized by tying these system together for maximum effectiveness and representing a saving in capital investment of about forty million dollars. Mr. Harriman pointed out that the present New England 66,000-volt interconnections have a circuit capacity each of probably not over 20,000 kilowatts. He forecasted the use of 220,000-volt trunk line interconnections in this region and maintained that the superpower zone should be extended to include the Pittsburgh and Cleveland districts, making the total yearly energy consumption requirements of the zone about fifty billion kilowatt-hours. In a masterly analysis of the hydro-electric resources of eastern Canada, the speaker said that these amount potentially to about one hundred billion kilowatt-hours per year. Supplemented by suitable steam plants, these resources are most encouraging in taking a long look in the future power requirements of the greater superpower region.

Water for intercoolers and aftercoolers on air compressors is best regulated by a thermometer in the *air* leaving the cooler. There is a point beyond which even an enormous increase in water quantity will not produce appreciably better intercooling. All water jackets should be so piped that they may be drained to insure against freezing in case the engine room should become cold. All first-class compressors are designed to provide for this, but the water piping should be arranged to accommodate this condition also. This also applies equally to intercoolers and aftercoolers. It is good practice to clean out the sediment and scale which may accumulate in the jackets. Large machines often have handholes in the outer jackets to assist in this cleaning, and the occasional application of scrapers and a waterhose will help on all sizes. Intercooler and aftercooler tubes need this attention occasionally.



A Matter of Engine Rating

THE builders of the air-injection Diesel are in fair agreement as to the mean effective pressure on which the rating of an engine is to be based. This has not been arrived at by any understanding, tacit or otherwise, but is the result of years of experience with engines in the field. It has been found that it is possible to burn fuel in a Diesel cylinder at a rate that will result in mean effective pressures based on brake horsepower of as much as 125 pounds. But these remarkably high rates of combustion are not obtained without some sacrifices in other directions. Not only does the thermal efficiency decrease by reason of imperfected mixture, but also by reason of the low expansion ratio, as indicated by the high exhaust temperature; the higher heat stresses also make evidence of their presence by more rapid cylinder and piston wear.

Without doubt an increased mean effective pressure would permit the use of a smaller engine for a given work, but this is not an unalloyed advantage, for the higher heat conditions demand better materials and workmanship. In fact, even if the high mean effective pressure engine be permissible on construction grounds, the decrease in efficiency would often preclude its use.

With the advent of the solid-injection engine the question of advisable mean effective pressures again comes to the front. While it is true that, by reason of the higher mechanical efficiency of the latter type engine, the brake mean effective pressure will be greater for the same indicated horsepower, this is somewhat offset by the lower effectiveness of the mechanical spray.

While engine builders may not be consistent in the pressures used in rating their machines, tests on a number of different engines reveal that the fuel-consumption curves have their lowest point at between sixty and seventy mean effective pressure. The natural conclusion is that there is a tendency to sacrifice efficiency and reliability for the sake of increased output.

The test code committee of the American Society of Mechanical Engineers should in the final code embody some recognition of this condition by stipulating the mean effective pressure range in which an engine is to be rated.

Likewise the question of maximum pressure should not be left entirely to the discretion of the builder. As is well known, it is possible to have the combustion carried on at practically constant volume, giving a sharp peak to the indicator diagram in place of the rounded top, which indicates that most of the combustion has occurred at a varying volume. The constant-volume sharp peak results in a considerable increase in the engine's thermal efficiency.

Since pressures may be taken to some degree as a measure of engine reliability and life, somebody should settle the question as to whether the increased efficiency justifies the extremely high pressures that are natural results of the constant volume combustion, and a purchaser should be given information as to not only the compression pressure but also the maximum pressures at full load. Engine types do not differ so radically that these vital factors cannot be as standardized as are similar points in steam-engine design.

Time To Take Stock

AFTER five years of more or less intermittent discussion by the Military Affairs Committee of the House and the Senate Agricultural Committee, the latter continues to hold hearings on Muscle Shoals, with the problem apparently little nearer solution than at the start. The testimony of interested persons, public men and experts, would fill several volumes. The necessary data are a matter of record. Is it not time then to act on the President's recommendation for the appointment of a small joint committee to sift all these facts and arrive at some definite conclusion based upon a broad conception of what is to the public interest?

Considered from a monetary standpoint, the power companies' offer is undoubtedly more attractive than that of Mr. Ford. The latter's promise of cheap fertilizer, however, has made a strong appeal to the farmer. Those favoring the power companies' offer see great benefits through rendering this power available to the diversified industries throughout that section of the South. Opposed to this is the picture of a great local industrial development that would follow Mr. Ford's acquisition of the properties. Aside from a general confidence in the personal integrity and industrial leadership of Mr. Ford, his offer carries few definite guarantees of the fulfillment of these expectations, and it must be recalled that he is already a man past middle age.

These are but a few of the arguments on either side, but in weighing their relative merits, has not the primary interest of the government in the project been overlooked? The nitrate plant was constructed for the purpose of rendering the government independent of an outside source of nitrates for ammunition. As such, it is just as much a part of our permanent military establishment as any one of the arsenals. The hydro-electric plant was conceived with the idea of rendering available a large amount of power for the nitrate plant. That considerable excess power would be available was incidental to the main purpose. Is it wise then, for the government to relinquish title to these properties? The cost of the nitrate plant may be looked upon as a war expenditure. Many millions have already been expended on the dam and hydro-electric plant which are well advanced toward completion. It has been suggested that the government complete this work and then, having taken stock of its expenditures and activities, dispose of this power on the most advantageous terms, retaining title to the properties in accordance with the original conception of the project. May not this suggestion be worth the Committee's earnest consideration?

The Value of Tests

THERE is a tendency among engineers to apply without qualification the results of a test to computations showing the economies to be expected in daily operation. Frequently, when the conclusion has led to an alteration in existing machinery or in installation of new equipment actual performance fails to meet the expectations aroused by the test data. Too frequently the disappointment prompts the utterance of doubt concerning the testing engineers' honesty and ability. This is highly unfair, but the engineer who ran the test is not without blame, for he should have taken pains to point out that the results should not be used without reserve since the conditions were as nearly ideal as possible. Even when a test is conducted under conditions resembling as far as is feasible, actual service conditions, everyone concerned is at pains to see that the equipment is given the best attention as to manipulating procedure. It is, then, not strange that after the zeal of the operating force has somewhat cooled, the test efficiency fails to be maintained. With this in mind engineers should accept with considerable reserve data of tests when applying them to operating calculations, no matter how accurate the test may have been conducted.

Re-inventions

NOT so long ago the engineer of a country cotton gin proudly exhibited to visitors a wonderful engine he had invented and spoke darkly of conspiracies on foot to steal the child of his brain. To the uninitiated it was impressive to see two pieces of pipe mounted on a hollow shaft spinning madly, and it must be admitted that the rainbow created by the sun falling on the jets of steam blowing out of the tips of the revolving arms was beautiful. What good would it have done to destroy the inventor's enthusiasm by the statement that two thousand years ago Hero found delight in the same toy?

Engineers just now are talking enthusiastically of the high efficiency obtained by bleeding the turbine at several points to heat the feed water. Some are likewise advocating the use of pressures of over one thousand pounds, while others argue the advantages of reheating. Many, especially the younger men, are of the opinion that these ideas are brand new. For the advantage of these it is well to mention that although having all the appearance of freshly made ideas, they actually were brought out long ago and are now merely being taken from a back shelf and dusted off.

The process of bleeding between stages is not only an old idea, but was in actual operation over twenty years ago. In 1906 Professor O. P. Hood, in a paper read before the American Society of Mechanical Engineers, described the results obtained in a Nordberg air-compressor unit in which the regenerating or bleeding system was used. In the discussion, mention was made of the possibilities of the system applied to the steam turbine, then in its infancy. In fact, this arrangement had been applied to a Nordberg compound engine several years prior to the construction of the compressor unit. Similarly, the reheating cycle, which is creating so much comment, was adopted by Charles D. Mosher in the construction of the "Arrow," a speed boat of a score of years ago. In this boat was installed a high-expansion engine using superheated steam at four hundred and fifty pounds. After leaving the high-pressure cylinder, the steam was reheated, as was also the case before it entered the low-pressure cylinder, the steam being kept in a superheated condition during the entire expansion period. The thermal efficiency was equal to the best present-day central-station practice.

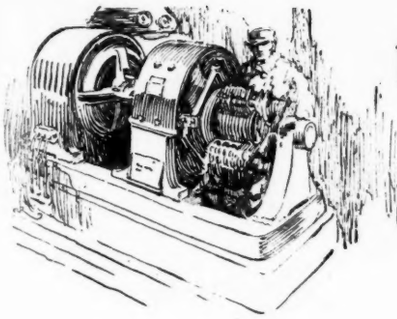
A similar story could be told of high-pressure steam. A hundred years ago Jacob Perkins patented a boiler which operated at the critical pressure of steam. He likewise patented a unaflow engine, described on another page, and was so bold as to advocate compounding in the face of engineers' protests that compounding and high pressures were detriments.

There is no mystery as to why these bold ideas were shelved for such long periods. Thermal efficiency must always step aside in favor of commercial efficiency, and as long as coal was cheap there was no incentive to make use of systems demanding high initial costs for the machinery. A further detriment to these inventions being put to use was the undeveloped state of the metal-working art. So poor were available materials that even fifty pounds pressure was dangerous

An Open-Minded Report

THE investigation of New England's power resources under the auspices of the Associated Industries of Massachusetts, abstracted elsewhere in this issue, covers the subject with skill and condensation, considering the magnitude of existing and potential power developments in that region. As Mr. Main pointed out, in explaining the report to a large audience of engineers and business leaders at Boston on April 29, the report does not claim to solve any specific power problem, but it contains such a valuable assembly of digested data on steam and hydro-electric costs for industries and utilities and throws so much light upon the economics of future developments that it constitutes a comprehensive contribution to the subject.

Only passing mention can be made here of the committee's conclusions, but perhaps the most interesting is the finding that Canadian hydro-electric power has an economic market in New England which will be of reciprocal benefit in releasing fuel for many purposes elsewhere, granted proper international anrrangements and, of course, engineering development along financially justified lines. In discussing the report, one of its signers, H. I. Harriman, of the New England Power Company, pointed out that the potential hydro-electric resources of eastern Canada exceed one hundred billion kilowatt-hours per year, or double the prospective energy requirements of a greater superpower zone extended to include the Pittsburgh-Cleveland districts. Steam plants of the best type interconnected with the hydro-electric stations, will form the backlog of industrial and general energy supply. Costs of independent power production in the woolen and other industries using large amounts of process steam enrich the report from the viewpoint of the industrial-plant engineer, and indicate that the road to economy in power supply has no short cuts in place of conscientious engineering investigation of every specific problem. Although the larger part of New England's growing industrial load will, in the opinion of the committee, be met by central-station service, it is shown that the industrial power plant still meets the needs of nearly half the demand of that section and can justly be displaced only on the basis of bedrock economic facts and studies in specific cases that demonstrate the wisdom of the change.



Practical Ideas *from* Practical Men

Removing a Stuck Piston in a Compound Engine

In a manufacturing plant in Brooklyn, a 22x42x48-in. Corliss tandem-compound engine had a badly scored piston rod and preparation had been made to replace it with a new rod. The job had to be done at night after the plant was shut down. The erecting man first assured himself, by measurements, that the new rod was right for that engine, then the connecting rod, distance pieces, cylinder heads, high-pressure piston, the follower plate and bull ring of the low-pressure piston and the packing from the three stuffing-boxes were removed, but no amount of pulling or driving would start the rod from the low-pressure spider.

Chain blocks were rigged from the crank to the crosshead and a strain taken on it, to hold the spider firmly against the crank-end cylinder head. An 8-ft. length of railroad rail was slung by a stout rope from an overhead beam to serve as a ram, as shown in the sketch.

Two pieces of board were then nailed together to make a V-shaped guide for the ram, and a piece of pig lead was placed at the end to prevent battering the end of the rod. After several smart blows with the ram failed to start the rod, two gasoline torches were placed in the cylinder with their flames impinging on the hub of the spider, and wet rags were kept on the rod, close to the spider, to keep the rod cool. In about two hours the hub had become quite hot and the ram was tried again, with the result that at the first blow the rod shot out. The tapered rod and the hole in the hub of the spider were found to be very rough, and they were rusted together. It was learned from the engineer that some two years before the nut holding the low-pressure piston had become loose, allowing the piston to slam back and forth on the taper several times before the engine could be shut down, which was the probable cause of the roughened taper. It was now only a short job to insert the new rod and reassemble the engine, ready to start on time in the morning.

M. M. BROWN.

Utica, N. Y.

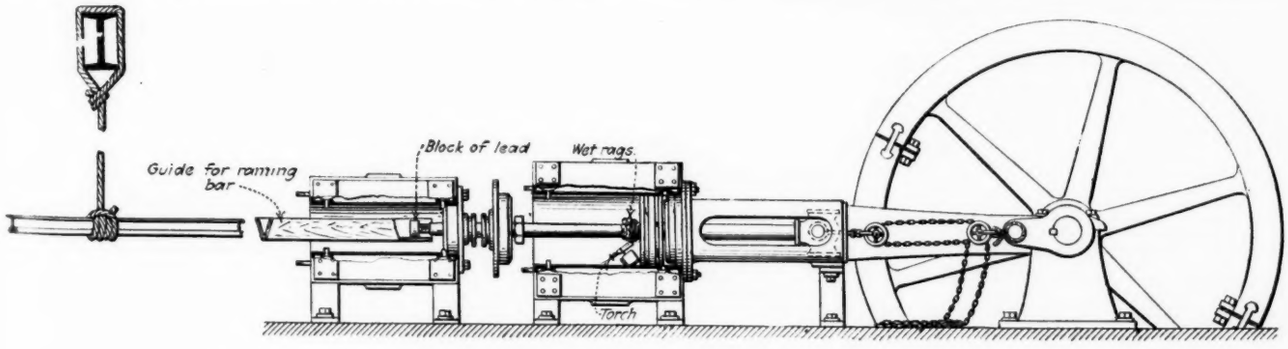
Hints on Cutting Glass Tubes

The following practical hints on cutting gage glasses, glass cylinders, bottles, etc., will no doubt be useful to many readers. Especially to those who do not possess a lathe or find difficulty in obtaining the use of a lathe for the purpose of cutting glass tubes, etc., in power plants.

One simple method of cutting glass tubes is to obtain a piece of $\frac{3}{32}$ or $\frac{1}{8}$-inch diameter wire. Bend one end a semicircular shape to fit closely round the tube, or cylinder to be cut, leaving about 8 or 10 inches for the handle. First, tie around the tube on one side of the line a thin piece of asbestos sheet or string. Then heat the half-round end of the wire until it is red hot and quickly place the loop on the tube close up to the asbestos tied on as a guide. Turn the tube or cylinder around slowly so that it gets evenly heated all around, then quickly remove the wire and plunge the tube into water, when it will fracture along the path traversed by the hot wire.

Another simple method of cutting glass tubes is by filing, using a mixture of turpentine and camphor as a lubricant. This lubricant is best made by putting turpentine in a cup or similar vessel, and putting as much camphor in as the turpentine will hold in solution. If the file is kept wet with the lubricant, glass cylinders, tubes, etc., can be readily cut to any shape. With the use of this lubricant, holes up to $\frac{1}{2}$ in. in diameter can also be drilled in glass when a flat drill has been hardened in sulphurous acid.

Another method of cutting glass tubes is by means of an acetylene or gasoline torch or the ordinary mouth blowpipe flame. The blowpipe should be so adjusted that a very small pencil-like flame is obtained.



Tackle and method employed in removing piston rod from compound engine

To cut a glass tube or cylinder by this method, first wrap two rather thick bands of damped blotting paper neatly and snugly around the tubing, one band on each side of the cutting point, leaving approximately $\frac{1}{8}$ in. of the tube bare, then mark with a file in the center. The tubing may be suitably supported on two grooved wood blocks, leaving a space between them for the flame to play directly on the narrow surface of the glass between the damp papers and at the same time rotating the tube slowly and evenly so that the whole of the bare strip becomes heated. In a few seconds the tube will break cleanly all around the exposed portion. In the event of thick-walled gage glasses, it is usually necessary to run a few drops of cold water onto the paper bands, the probable cause of the clean fracture being the great difference in temperature between the adjacent portions of the glass under the flame and under the colder paper.

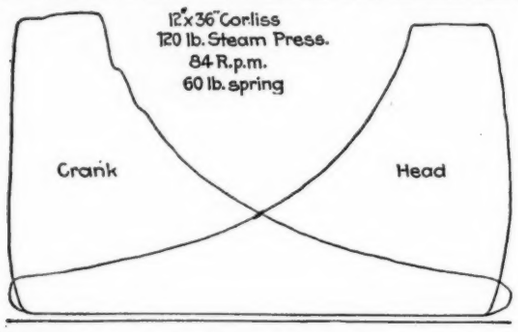
If there should be some sharp edges or points, they can easily be removed by briskly rubbing them on carbide of silicon, or emery powder moistened with water and spread on sheet glass or an iron plate.

Manchester, England. E. ANDREWS.

Diagrams from Forty-Year-Old Corliss

The indicator diagrams shown herewith were recently obtained from our 12x36-in. Corliss engine and may be of interest to other readers in view of the long time the engine has been in operation.

The engine is a Hamilton Corliss No. 33 and has seen



Diagrams from Corliss after forty years' service

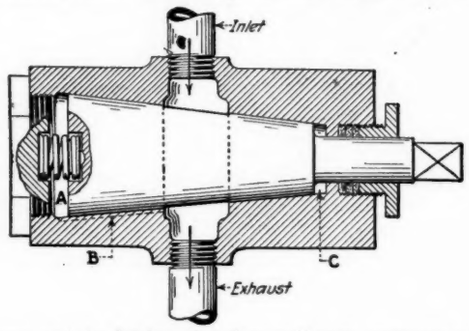
continuous service since 1884. The load in that time has gradually increased with the increase in mill capacity, but the power equipment has remained the same, taking care of it nicely with no overload.

I should like to have have some criticism on these diagrams from readers of *Power*. JERRY BEAMER.

Tiffin, Ohio.

How the Plug Valve Was Made to Turn Easily

Recently we bought an hydraulically operated machine of which the plug valve shown in the cut was a part. This valve operated under a water pressure of 120 lb. per sq.in. and worked satisfactorily except that it turned so stiffly under pressure that it could be moved only with difficulty. Lubricating the plug gave only temporary relief, and putting in a weaker spring made little difference. After much trouble and experimenting, I removed the plug and with a three-cornered file cut the groove shown by the dotted line *B* connecting the chamber *A* with the exhaust. This completely eliminated the trouble, as it prevented the pressure building up in the chamber *A* at the large end of the plug. Any pressure that builds up in the chamber *C* tends to



Groove cut in body of valve relieves pressure from large end of plug

relieve the plug and causes it to turn more easily, while the reverse action took place in the chamber *A*.

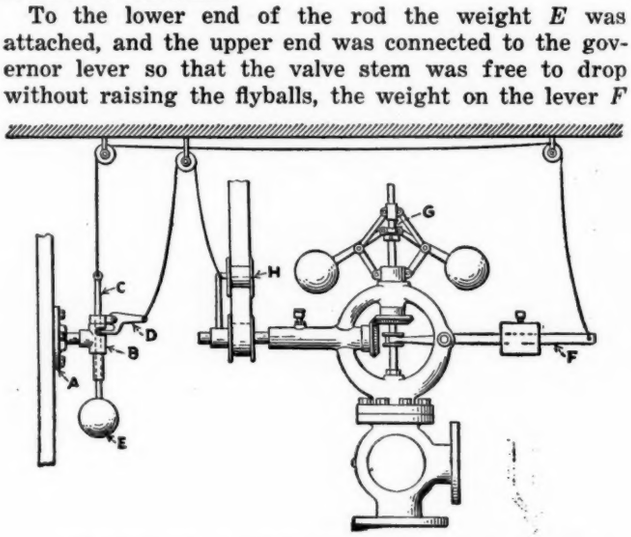
Vancouver, B. C. R. MANLY ORR.

Improvised Safety Device for Throttling Type Governors

The illustration shows a safety device that I placed on our engine some time ago and that proved quite satisfactory. It was made from material found around the plant.

Referring to the illustration, the floor flange *A*, carrying a short nipple and a $\frac{1}{2}$x$\frac{1}{2}$x$\frac{3}{4}$-in. tee, was fastened to the wall adjacent to the engine. Nipples were screwed into each end of the tee to act as guides for the latch rod *C*. The tee and latch rod were notched as shown to receive the latch *D*, which was made in the form of a bell crank.

To the lower end of the rod the weight *E* was attached, and the upper end was connected to the governor lever so that the valve stem was free to drop without raising the flyballs, the weight on the lever *F*



Arrangement of safety stop applied to throttling governor

being sufficient to hold the stem against the collar *G* in the regular operation of the governor.

The device functions as follows: Should the governor belt break, the idler *H* drops and by means of a cord passed through a pulley on the ceiling releases the latch *D*, allowing the weight *E* to drop and pull the governor valve shut. G. T. WHITE.

Portsmouth, Ohio.

Comments from Readers

Slipshod Lubricating Methods

I feel sure that the editorial in the Feb. 5 issue on "Slipshod Lubricating Methods" will prove of much value to many readers of *Power* who are engaged in the maintenance of power-transmission installations, because it is evident that there is ample room for progress in the lubricating methods employed in industrial plants.

As is known, under certain conditions the dust of many organic substances, such as starch, flour, meal, coal, etc., is capable of exploding with tremendous violence. The dust of these substances becomes especially dangerous when floating in the air in a finely divided state. It may also be ignited when deposited on belting, shafting or machinery, the resulting blaze causing an explosion. Investigations into a recent explosion revealed that an overheated bearing ignited a cloud of very fine dust particles. If plant maintenance and the inspection of operating equipment were properly carried out, explosions from causes of this kind could be averted.

In view of all that has been written concerning lubrication, it is surprising that many machine users even yet do not appreciate the fact that a lubricant is virtually a constituent part of any machine and, as such, should be given the fullest consideration. Quality should be insisted on, and when once a particular grade has been found really suitable, its use should be persisted in. It is a mistake to suppose that an oil that is found to be an efficient lubricant for one specific application will, of necessity, exhibit an equally high efficiency for some other purpose.

Until the last few years the value of a lubricant was arbitrarily fixed in terms of its viscosity, or "body," but the work of several investigators has shown that the real value of a lubricant lies in some physical characteristic of the oil itself, believed to be the presence of a minute quantity of organic fatty acids. This assertion is strengthened by the fact that mineral oils that are free from trace of these acids are poor lubricants under trying conditions. Recent experiments have been successfully concluded to demonstrate the feasibility of incorporating definite percentages of certain organic acids in these mineral oils, thereby effecting a considerable reduction in friction losses.

A good lubricating oil must adhere tenaciously to the rubbing surfaces; it must form a liquid cushion between these surfaces; it must withstand and not become displaced by any pressure, blow or shaking motion; it must not lose by evaporation, either at ordinary temperature or at the highest temperature to which it may be exposed while in use; moreover, it must not become chemically changed while in use. It must combine the highest possible fluidity with the greatest cohesion and should maintain its state of fluidity as nearly uniform as possible within reasonable changes of temperature

With regard to power-transmission installations lubrication comes within and is a part of the daily duties of the men in charge of bearings, shafting, pulleys, gears, etc., the main thing being for them to see that the sight-feed lubricators and reservoirs usually provided are well supplied with oil. Where a reliable man is in complete charge of the oiling, trouble from the bearings will rarely be experienced. There is, however, the liability of the man in charge relying too much on the automatic oiling devices, and unless he is conscientious in his duties, an overheated bearing is the first intimation of his being lax or the failure of the automatic equipment to supply the bearing with oil properly. In any case it is essential from every point of view that no one man be put in charge of more than he can deal with efficiently. Shafting must be inspected frequently to make sure that it runs true, that the hangers are not working loose and that the bearings are receiving proper lubrication. The extra cost for an additional man to carry out this work effectively is money well invested, if only to avoid the too frequent stoppage during working hours. Correct lubricating methods would also prevent bearings from overheating to the point where they start fires; the extra expense for labor, therefore, would be a cheap form of insurance.

Manchester, England. E. ANDREWS.

What Is Meant by the Term "Burden" in the Cost of Coal Handling

In the Jan. 29 and March 4 issues of *Power* are discussions by G. E. Titcomb and H. E. Birch, on the cost of coal-handling by various methods, which include tables of cost data. Following is a copy of the table accompanying Mr. Birch's discussion:

COST OF OPERATION (8-HOUR DAY)

One operator	$5.00
Burden (150 per cent of labor)	7.50
Current, 240 kw.-hr. at 3 cents	7.20
Oil, etc.	.50
Repairs and replacements	1.00
Interest on investment	3.00
Taxes and insurance	1.50
Depreciation and obsolescence	3.00
	$28.70

The following is a copy of Table IV from Mr. Titcomb's discussion, which was also reproduced by the editor in the March 4 issue:

COST OF OPERATION (8-HOUR DAY)

One operator	$8.00
Two helpers for dumping cars	10.00
Burden (150 per cent of labor)	27.00
Current, at 1 cent per ton	7.50
Oil, etc.	2.00
Repairs and replacements	4.00
Interest on investment, 6 per cent on $15,000	3.00
Taxes and insurance	1.50
Depreciation and obsolescence	3.00
	$66.00

In both these tables is an item designated "Burden (150 per cent of labor)." In the first table this item is 26 per cent and in the second approximately 41 per cent of the total. Now, what do these items represent? "Burden," as I understand it, is "overhead," or whatever does not contribute to labor, material or selling

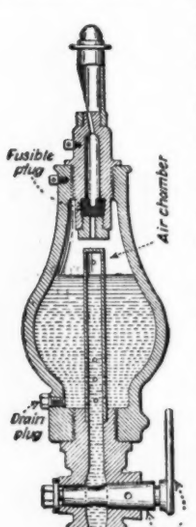
expense. The tables show every item entering costs with the possible exception of administration, or supervision, and rental on that portion of the plant allotted to the coal-handling equipment, so why a "burden" charge of 26 and 41 per cent of the total? I would be glad to see an explanation. C. O. SANDSTROM.

Kansas City, Mo.

Steam-Boiler Fittings in Holland

To quote the A. S. M. E. Boiler Code, Paragraph 317 reads: "The feed pipe shall be provided with a check valve near the boiler and a valve or cock between the check valve and the boiler."

In this country the check valve and stop valve or cock are often combined and, if possible, connected directly to the boiler. Where a valve is used, a test or drain cock should be fitted to the feed-water valve body between the check and the stop valve, in order to make sure that the valve is closed before the cover above the check valve is removed for inspection or repairs. Moreover, if the valve is leaking, the hot water can be drained, and thus facilitate the work of inspection or cleaning. Therefore, it is advisable to fit a test cock to all feed-water valve bodies near the boiler whether a valve or a cock is used.



Safety whistle and connections

With further reference to the Code Par. 295 reads: "No outlet connection, except for damper regulator, feed-water regulator, drains or steam gages, shall be placed on the pipes connecting a water column to a boiler."

In my opinion no outlet connections at all should be tolerated, for with outlets on the pipes connecting a water column even a small leak tends to reduce the steam pressure in the gage glass and cause a correspondingly higher water level therein.

In this country water-tube boilers are never fitted with fusible plugs in the drums or tubes in order to reveal a dangerous condition; instead, they are provided with a safety whistle, connected to a pipe projecting through the top of the drum and extending to the lowest permissible water level. When steam is raised, the liberated air is compressed and the pipe is filled with a mixture of air and condensed steam, and this condition will not change if the water level is kept within normal limits. When the water level reaches the dangerous limit, steam replaces the water in the pipe and melts the fusible plug in the inlet opening of the whistle. Then the fireman is warned by the blowing of the whistle and has a chance to correct the trouble or take the boiler out of service before any damage results. After shutting off the steam by means of the cock *A*, the whistle can be removed and a new fusible plug inserted. When blowing down the boiler for cleaning or inspection, it is a good plan to leave the cock open in order to test the reliability of the whistle.

The use of cast iron in economizers and superheaters is not allowed, unless the internal diameter of the tubes, exposed to the gases, is less than two inches.

Economizers are fitted with a blowoff cock, a check valve at the inlet and a safety valve with a diameter of not less than $1\frac{3}{8}$ in. and set to blow at 10 per cent above the boiler pressure. A similar safety valve should be used on a superheater if a stop valve is placed between the superheater and the boiler.

Valves in the water-column connections of Scotch marine boilers are considered to be in accordance with good practice and safe operation. (The return-tubular boiler is not used in this country.) One builder runs the water-column connections, in this case a set of heavy flanged wrought-steel pipes, through the smoke-box, the column itself being arranged to have two water gages connected to it.

Cast iron is not allowed in the construction of safety-valve or main-stop valve bodies, when the internal diameter of the inlet opening exceeds 4 in. and the steam pressure is more than 150 lb. gage, nor is it used in the general construction of steam boilers. Consequently, the application of cast-iron headers to water-tube boilers is strictly prohibited.

The remaining paragraphs of the Dutch National Boiler Rules conform fairly well to the A. S. M. E. Boiler Code, although I consider the latter more explicit and in detail. H. WIELAND LOS.

Schoonhoven, Holland.

American and European Hydraulic Turbine Practice

In the issue of Feb. 19 appeared two communications, one from H. B. Taylor, the other from W. M. White, containing statements that should not remain unchallenged. I refer to Mr. Taylor's statement regarding the backward state of turbine design in Europe in general. I hesitate to believe that Mr. Taylor made this statement from personal experience or after having personally satisfied himself regarding the correctness of these reports emanating from American engineers who visited Europe during the last few years. There has been such a tremendous amount of important work done in recent water-power developments as well as in research work on the part of European engineers and manufacturers that his statement is incomprehensible to anybody who has followed the progress made. The propeller-type turbine especially has been developed during the last few years. The firm with which the writer is connected in Switzerland had at the end of last year the test results of over 600 propellers and units up to 9,500-hp. in operation. Other firms in Germany and Sweden have done likewise. European engineers are giving full credit to American enterprise as shown in the large-sized propeller units installed for the Manitoba Power Co., but the fact that one or two American firms have installed larger or more powerful machines than could be used advantageously in Europe does not justify Mr. Taylor's statement that America has outdistanced Europe. American engineers have had greater opportunities owing to the greater resources of their country, while Europe was suffering from the result of the war with consequent financial disarrangement which stopped large private enterprises for over five years.

Mr. White claims that for at least half a century America has set the pace in efficiency, that for practically the entire history of the development of modern waterwheels, all records of head, horsepower, physical dimensions and efficiency have been held by America.

He seems to have forgotten that only 25 years ago no American firm was able to design the water turbines required for the Niagara plants, which were ordered from Switzerland for the first two installations, while for some of the subsequent plants the turbine designs were made by the same firm when the machines were built by American manufacturers. Mr. White seems to have forgotten that his own company engaged for years Swiss engineers to design its waterwheels and is even now retaining Swiss engineers in its American and Canadian plants. He seems to forget that even in American textbooks as late as 1907 and 1908, American turbine designs were severely criticized as being done unscientifically. The fact is that the whole of the modern American turbine design is built up on the scientific work of European hydraulic engineers, such as Pfarr, Camerer, Prasil, Allievi, Dubbs and various others.

Mr. White does not seem to know what has been done by European engineers and manufacturers since the Keokuk plant was first started, otherwise such statements as the foregoing could not have been made. Units of 40,000 and 80,000 hp. for one of the Niagara plants were already designed and proposed by a Swiss company as early as 1913. On the other hand, great numbers of European turbines have been bought and installed by American engineers in plants built by them in Canada, Mexico and South America. One Swiss company, for instance, has built or designed practically every waterwheel installed by the famous American engineer, Dr. F. S. Pearson, who was acknowledged to be the pioneer of large modern hydro-electric enterprises.

It is true that American manufacturers are now competing in foreign markets with somewhat better results than was the case ten years ago, when very few foreign buyers would adopt water turbines built in America. Such statements, however, as given out by Mr. White, that his company has sent to Japan during the last few years turbines aggregating half a million horsepower capacity, do not seem to be in accordance with the records, since there were not even half of this capacity of turbines imported during the last ten years, by Mr. White's company, unless the official reference lists for Japan given out by his company are short one-quarter of a million horsepower.

TH. SEIDL,
Chief Engineer Escher Wyss & Co.,
Tokyo, Japan. Zurich, Switzerland.

Outside Temperatures of Steam Pipes

Referring to the request of L. D. Anderson, in the March 4 issue, for information regarding the temperature of the outside of steam pipes, the following may be of interest:

About two years ago I conducted some experiments on a 10-in. pipe which showed the temperature of the outside of a well-insulated steam pipe to be not more than 2 deg. F. lower than that of the steam in the pipe. The readings were taken on a steel pipe running from the boiler to the turbine and having a nominal thickness of 0.365 in. The temperature of the steam inside the pipe was measured with a thermocouple which was welded into the bottom of the thermometer well extending 3 in. into the pipe. In attaching the thermocouple, the bottom of the well was drilled through so that the hot junction was exposed directly to the steam.

The temperature of the outside of the pipe was also measured with a thermocouple, the hot junction being attached by inserting it in a small hole drilled in the outside of the pipe and peening the pipe metal around it, thus making a tight fit. The hole drilled in the pipe wall was not over $\frac{1}{8}$ in. deep.

The pressure of the steam in the pipe averaged 220 lb. gage and its total temperature ranged from 600 to 675 deg. F. (205 to 280 deg superheat). The pipe was covered with a 4-in. layer of 85 per cent magnesia.

Several series of observations were made with readings of the steam and outside pipe temperatures taken simultaneously once each minute for periods of 30 minutes at a time. These observations were made with various amounts of steam passing through the pipe, the range being from 91,000 to 152,000 lb. an hour. In general, the temperature of the outside of the pipe was not more than 2 deg. F. lower than that of the steam, and at times when the steam temperature was constant for three or four minutes, the outside pipe temperature became equal to it. In one case the steam temperature changed 20 deg. in 13 min., yet the outside pipe temperature followed along with a lag of not more than one minute.

Upon this basis it seems proper to assume in computing pipe expansion that the pipe is at the temperature of the steam flowing through it, provided it is adequately covered.

STERLING S. SANFORD.
Detroit, Mich.

Oil Engines in Cotton-Seed Oil Mills

Under the title, "Oil Engines Practical Even If Process Steam Be Needed," J. S. Le Clercq, of the Dallas Oil & Refining Co., presents in *Power*, Feb. 26, an interesting analysis and his solution of an engine-room phase of the cotton-seed oil industry.

He is quite right in stating that the expeller is used in connection with the cold-press system; however, he should not have stopped at this point, for the expeller is not only used for pressing whole seed and making what is known as cold-pressed oil and cake, but is also used for pressing cotton-seed meats. On this material the expeller shows much greater economy and equally as good if not greater yield of oil than that obtained from the hydraulic process.

Millers using the expeller press, may separate the meats and hulls before pressing, thus producing a high-protein cake. There is also obtained an oil of better grade and color than hydraulic oil, explained in part by the fact that the seed, in preparation for pressing in an expeller press, is merely preheated and not cooked. The tempering apparatus used with the expeller press is a steam-jacketed heater; the seed and meat never come in contact with live steam.

A point of economy to be stressed in favor of the expeller process, has to do with the production of the expeller press, working whole seed. This yield averages 1,600 lb. of cake per ton of seed, the hulls being mixed integrally with and sold as a part of the cake. With the hydraulic press restricted, as it is, to the use of separated cooked meats, the production per ton yields approximately 850 lb. of cake and 750 lb. of hulls, the hulls being separated from the cake and sold as hulls. A profit balance for the expeller process of about $2.50 per ton of seed results.

H. E. EMERY, Vice-President,
Dallas, Texas. Western Engineering Co.

QUESTIONS AND ANSWERS

Conducted by Franklin VanWinkle

Feeding Boilers Under Different Pressures from the Same Feed Pump

If a battery of three boilers is fed by a single feed pump and one of the boilers is cut out of the line and its pressure allowed to drop to 50 lb. gage, would there be an equalization of pressure from feeding all boilers at the same time when carrying 100 lb. pressure in two of the boilers? B. G.

Each boiler is presumed to be fitted with a feed stop valve and a check valve, and there would be no back flow from the boilers that carry 100 lb. pressure, except from leakage of their check valves at times when the pressure in the feed line might be less than 100 lb. pressure. However, to feed all boilers at the same time, the feed pump must maintain sufficient pressure in the feed lines to supply the boilers that carry 100 lb. pressure. Then to prevent the feed-line pressure from falling too low for that purpose, or to prevent too rapid feeding of the boiler that carries 50 lb. pressure, the feed stop valve of the latter must be throttled.

Advantages of Modern Direct-Acting Steam Pumps

In a modern direct-acting steam pump used for boiler feeding, why is it possible to dispense with a flywheel, and what is the disadvantage of requiring a flywheel? L. W. H.

In the earlier designs of steam pumps a connecting rod, crank and flywheel were necessary for obtaining momentum to reverse the direction of the stroke, and a single pump could not be run very slowly or started with the crank on dead center. In modern direct single steam pumps the steam admission valve is steam-thrown and is reversed at the end of the stroke by pressure of live steam under control of an auxiliary valve that is operated by motion of the main piston when near the end of its stroke. In ordinary duplex pumps the engine of one side of the pump, before completing its stroke, operates the valve gear of the other engine. Modern pumps, besides requiring no flywheel for reversing the stroke, may be operated as slowly as desired and may be started at any point of the stroke.

Turning Screwed End Piston Rod to Adjust Piston-Travel Clearance

When the piston rod of an engine is screwed into the crosshead and secured with a jamb nut what is the objection to equalizing the piston travel clearance by turning the piston and rod for changing the distance the rod is screwed into the crosshead? R. M. C.

Without information founded on careful inspection of the fitting, there may be doubt as to the number of turns the rod should be moved in the crosshead, and when used for some time after being properly placed, the objection to disturbing the setting of the piston rod is that the screw threads are brought to new bearings and are more likely to work loose. Another objection to turning the rod in the crosshead is that the piston is likely to be turned to a different position with respect to its wearing places in the cylinder, although great care may be taken to give the piston rod an even number of turns at the expense of exact adjustment of the piston clearance. For these reasons it is better to obtain equalization of piston travel clearance by adjusting the length of the connecting rod.

Dropping of Water Level of Boiler

Why does the water level shown by the glass gage on our water-tube boiler drop out of sight from ¾ of a gage when we shut down at noontime? L. B.

When steam is generated in the water tubes or other water spaces of the boiler, and before it rises into the steam space of the boiler, it displaces an equal volume of water, causing higher water level, and so long as formation of steam continues below the surface of the water, its level must remain higher than if no such displacement existed. When the engine is shut down and the boiler continues to receive heat from the fire, with no steam escaping from the steam space, there is increase of pressure and a building up of pressure mainly from surface evaporation and less displacement of the water from formation of steam below the surface of the water. If the fires are checked so there is no generation of steam, and consequently no displacement of the water, the water space becomes filled with solid water without any displacement by steam bubbles, and there is corresponding lowering of the water level.

Small Undershot Waterwheel

We wish to construct a small undershot waterwheel 20 in. to 24 in. face, with flat float boards, 4 to 6 in. wide, for utilization of 25 ft. of head. Would a 6-ft. or an 8-ft. diameter wheel be more efficient, and what should be the speed for either size of wheel for best efficiency? H. H.

With 25 ft. head the theoretical velocity of the water would be about 40 ft. per second and the velocity of the wheel giving the best results would be about one-half, or 20 ft. per sec. = 1,200 ft. per min. for the middle of the floats. A wheel 6 ft. diameter with floats 6 in. wide would have an effective diameter of 5 ft. 6 in., or $5.5 \times 3.1416 = 17.28$ ft. circumference, and the speed for best efficiency would be about $1,200 \div 17.28 = 69.4$,

or practically 70 r.p.m. A wheel 8 ft. in diameter with floats 6 in. wide would have an effective diameter of 7 ft. 6 in., or 7.5 × 3.1416 = 23.56 ft. circumference, and the speed for best efficiency would be about 1,200 ÷ 23.56 = 50.9, or practically 50 r.p.m.

The efficiency may be considered to be the same for either size of wheel, the maximum efficiency being for that speed which gives the least velocity to the discharged water. This class of wheel, when constructed with curved floats with the concavity backward, and adjusted in position and form so that the water may be supplied to them without shock, and drop from them to the tailrace without any horizontal velocity, has been constructed to give as high efficiency as 60 per cent. But with flat floats the maximum theoretical efficiency is but 50 per cent and the available efficiency is much less, seldom exceeding 15 per cent.

Horsepower per ton of Refrigeration

Can you provide a table showing the actual horsepower as well as the theoretical required per ton of refrigeration? *M. L.*

A ton of refrigeration is the removal of 288,000 B.t.u. This is usually assumed to be done in 24 hours, making the heat removed per minute 200 B.t.u. This is termed a duty of one ton of refrigeration or work at the rate of one ton. The theoretical horsepower is that needed if there were no compressor losses; the actual indicated horsepower is the power calculated from an indicator diagram taken from the compressor and includes the compressor cylinder losses. The values under the heading "Input Horsepower" include frictional losses and are the values to be obtained from a compressor in good condition.

HORSEPOWER REQUIRED PER TON OF REFRIGERATING DUTY

Sat. Temp. in Evaporator	Saturated Temperature in Condenser 60	70	80	90	100	110
	Theoretical Indicated Horsepower					
—40	1.420	1.606	1.793	1.994	2.200	2.426
—20	1.037	1.202	1.363	1.523	1.712	1.907
0	0.6910	0.830	0.975	1.125	1.282	1.437
20	0.429	0.555	0.681	0.817	0.951	1.092
40	0.202	0.308	0.412	0.531	0.652	0.786
	Actual Indicated Horsepower					
—40	1.856	2.035	2.440	2.790	3.182	3.662
—20	1.262	1.490	1.730	1.987	2.302	2.678
0	0.795	0.974	1.165	1.380	1.620	2.499
20	0.473	0.622	0.781	0.959	1.150	1.368
40	0.215	0.337	0.462	0.613	0.777	0.968
	Input Horsepower					
—40	2.226	2.441	2.930	3.350	3.820	4.390
—20	1.514	1.788	2.078	2.384	2.763	3.210
0	0.954	1.168	1.396	1.653	1.944	2.998
20	0.567	0.746	0.937	1.151	1.380	1.640
40	0.258	0.404	0.554	0.736	0.933	1.162

Butt and Double-Strap Joint Triple-Riveted

What is the efficiency of a butt and double-strap joint, triple-riveted, where the tensile strength of plate is 55,000 lb. per sq.in., thickness of plate $\frac{7}{16}$ in., thickness of butt straps $\frac{3}{8}$ in., pitch of rivets in outer row 8 in., and diameter of rivet holes $\frac{7}{8}$ in.? *W. L. K.*

With tensile strength of plate 55,000 lb., thickness of main plates $\frac{7}{16}$ = 0.4375 in., thickness of butt straps $\frac{3}{8}$ = 0.375 in., pitch of rivets in outer row 8 in., diameter of rivet holes $\frac{7}{8}$ = 0.875 in., and assuming the strength of a rivet in single shear = 44,000 lb. per sq.in., in double shear 88,000 lb., and the crushing strength of plate 95,000 lb. per sq.in. of projected area, then for a length of the joint indicated by the dimension *P* in the sketch:

(1) Strength of solid plate = 8 × 0.4375 × 55,000 = 192,500 lb.

(2) Strength of plate between rivet holes in the outer row = (8 — 0.875) 0.4375 × 55,000 = 171,445 lb.

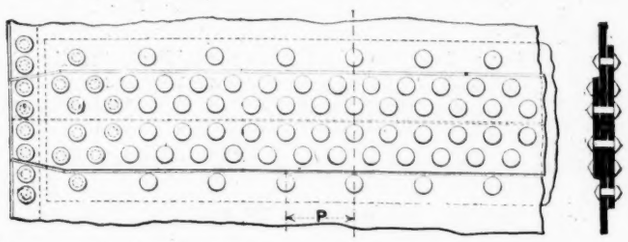
As the cross sectional area of a rivet filling a $\frac{7}{8}$ in. dia. rivet hole would be $\frac{7}{8}$ × $\frac{7}{8}$ × 0.7854 = 0.6013 sq.in.

(3) Shearing strength of four rivets in double shear, plus the shearing strength of one rivet in single shear = 4 × 88,000 × 0.6013 + 1 × 44,000 × 0.6013 = 238,115.

(4) Strength of plate between rivet holes in the second row, plus the shearing strength of one rivet in single shear in the outer row = (8 — 2 × 0.875) 0.4375 × 55,000 + 1 × 44,000 × 0.6013 = 176,848 lb.

(5) Strength of plate between rivet holes in the second row, plus the crushing strength of butt strap in front of one rivet in the outer row = (8 — 2 × 0.875) × 0.4375 × 55,000 + 0.875 × 0.375 × 95,000 = 181,562 lb.

(6) Crushing strength of plate in front of four rivets, plus the crushing strength of butt strap in front



Butt and double strap joint, triple-riveted

of one rivet = 4 × 0.875 × 0.4375 × 95,000 + 1 × 0.875 × 0.375 × 95,000 = 176,640 lb.

(7) Crushing strength of plate in front of four rivets, plus the shearing strength of one rivet in single shear = 4 × 0.875 × 0.4375 × 95,000 + 1 × 44,000 × 0.6013 = 171,926 lb.

As the least strength for a unit length of joint *P* is 171,445 lb., derived from consideration (2), the efficiency of the joint would be $\frac{(2)}{(1)} = \frac{171,445}{192,500} = 89$ per cent.

Discharge of Fire Stream

What distance should a fire stream be thrown vertically and horizontally through a 1¾-in. diameter nozzle supplied with water through 700 ft. of new smooth rubber-lined hose, with a pressure of 220 lb. per sq.in. at the hydrant or pump, and what should be the quality of water discharged? *S. H. S.*

From interpolation of "Fire Stream Tables" based on experiments, there should be pressure of 76 lb. per sq.in. at the base of the play pipe and a discharge of about 328 gal. per min. With a moderate wind an effective fire stream should be thrown 90 ft. vertically, or 80 ft. horizontally. The maximum limit of a fair stream would be about 99 ft. for a vertical stream and about 90 ft. for a horizontal stream.

[Correspondents sending us inquiries, should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Here and There in the Power Plant

Sidelights on things generally used but less generally understood

Handling an Orsat

THE Orsat apparatus may be equipped for measuring CO_2 alone or CO_2, O_2 and CO. That shown in Fig. 1 is of the latter type. Essentially the apparatus consists of a burette *D* for measuring the volume of gas and pipettes, *A*, *B* and *C*, for absorbing the various constituents in succession. The operation, briefly, is as follows: One hundred cubic centimeters (100 c.c.) of flue gas is drawn into the burette *D*. It is then forced over into the first pipette *A*, where a solution absorbs the CO_2. The remaining gas is drawn back into the burette for measurement, the shrinkage giving the amount of CO_2. Next the O_2 is absorbed in pipette *B* and the volume again measured in the burette. The additional shrinkage in volume gives the amount of O_2 present in the original sample. A similar procedure

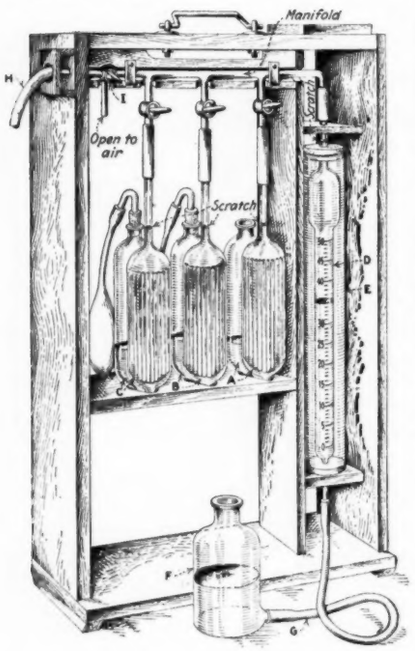


Fig. 1—Orsat apparatus for finding percentage of CO_2, CO and O_2

is followed with burette *C*, which removes the CO.

Table I shows the solutions used. These solutions, or directions for making them up, can usually be obtained from the maker of the instrument.

TABLE I—SOLUTIONS USED IN ORSAT

Pipette	Absorbs	Name of Solution
A	CO_2	Caustic potash or caustic soda
B	O_2	Pyrogallic acid
C	CO	Cuprous chloride

Fig. 2 is a cross-section of one of the pipettes. When ready for use, the solution fills the forward branch up to a scratch on the capillary tube and an inch or two in the bottom of the back branch. When the gas is forced into the top of the forward branch, the displaced solution rises in the back branch.

The rubber bulb shown protects the solution from the action of fresh air. This is necessary on pipettes *B* and *C*, as both the pyrogallic-acid and the cuprous-chloride solutions will absorb oxygen from the air and thus lose their absorbing power if not protected.

Bulbs *A* and *B* are full of small tubes When the liquid level is forced down, the tubes remain wet, which greatly accelerates the absorption. In pipette *C* thin strips of copper wire or sheet copper serve the same purpose and also help preserve the strength of the cuprous-chloride solution.

A small-bore glass manifold at the top of the apparatus connects the burette to each of the pipettes through individual cocks. By means of the three-way cock *I* the burette may be connected to the atmosphere or to the source of gas supply (through *H*). The movable bottle *F*, with the connecting tube *G*, operates a water piston to force gas out of *D* or draw it in.

Before taking a gas sample for analysis, the solutions must be brought to the scratches in the three pipettes. To do this, raise the bottle until its water level is about the same as that in the burette. Then open the cock in the pipette and lower the bottle slowly and steadily. This will lift the solution in the pipette. When the scratch is reached, the cock is closed. It is important not to let the solutions touch the cocks, as this will cause them to stick if not immediately removed, cleaned and coated with vaseline.

After the pipettes are leveled, *H* is connected to the source of gas supply. Cock *I* is then turned to connect the burette with the atmosphere, and the air is discharged from the burette by raising the bottle. Then cock *I* is turned to connect the burette with *H*, and a considerable quantity of gas is drawn into the burette by lowering the bottle. This is expelled to the air through *I*, and the process is repeated several times to eliminate all the air originally present in the burette and connections. Finally, a sample is drawn in filling the burette well below the lowest graduation.

The bottle is then held rigidly with its water surface exactly level with the lowest graduation (marked zero) of the burette and cock *I* is turned to connect the burette with the atmosphere. The water will then rise nearly to the zero mark, causing a slight fall of the water level in the bottle. A slight further raising of the bottle, keeping the water level continuously at the zero level, will bring the burette water exactly to the zero mark, whereupon *I* is closed and the bottle placed on the top of the case.

Water-level readings in the burette should always be taken at the bottom of the meniscus, which is the concave surface of the water. Care should be taken that the water level never falls

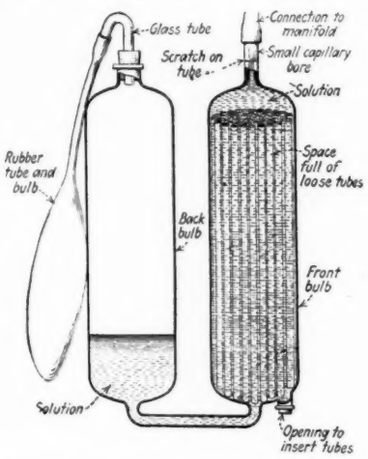


Fig. 2—Double pipette with rubber bulb

while the burette is connected to the air. Otherwise the sample will be diluted and made worthless.

If these directions have been carefully followed, the burette now contains exactly 100 c.c. of flue gas measured at atmospheric pressure and the temperature of the water jacket. The bottle is next held steadily beside the box with the water level about opposite the upper scratch of the burette. If the cock on pipette *A* is now opened the water will rise in the burette, forcing most of the gas into the pipette. As the water level falls in the bottle, the bottle should be gradually and cautiously raised until the water is exactly at the upper scratch in the burette, whereupon the cock should be closed.

After a minute or two for absorption of the CO_2, the cock is opened and the bottle gradually lowered until the solution comes back exactly at the scratch in the pipette. The cock is then closed and the shrinkage in gas volume measured by raising the bottle until the water levels are the same in the burette and the bottle. This is done in order that the gas may be measured at atmospheric pressure. To make sure that all the CO_2 is absorbed, the process is repeated until the same reading is obtained twice. The same process is then repeated for the other two pipettes.

Hydro-Electric Practice and Equipment in the South*

THE rivers of the Southeastern section of the country and their tributaries, originating on the southern part of the Appalachian Highlands, not having perpetual snows, depend solely upon seasonal precipitation for maintaining their flow. The average annual precipitation, which is greater than in any other part of the United States, ranges between 40 and 80 inches.

Although this region is for the most part heavily timbered, which tends to prevent sudden run-offs and equalize the river flows, the rivers are subject to high variations in flow. For example, the Tennessee River has a flow ranging from 7,200 to 430,000 sec.ft., recorded at Florence, Alabama.

The ratio of ainfall to the run-off has also almost as wide a variation as the river flow itself. It varies with the location and also with the amount of rainfall. While at the headwaters the ratio is 3:2 or better, in the lower foothills it varies from 4:1 to 2:1, the highest ratio prevailing in dry seasons or years, the lowest in wet periods. The following table gives rainfall and run-off data on the Upper Coosa basin for different representative years:

Year	Rainfall Inches	Run-off Inches	Approximate Ratio
1904—dry....	40	9.5	4:1
1906—wet....	63	30	2:1
1912—wet....	63	30	2:1
1916—average	47	18	2½:1

For the most part these rivers yield only run-off river power with very little primary, but a large amount of secondary power when supplemented with steam or power from storage reservoirs, can be utilized wholly or in part to good advantage. Practically every river on its headwaters or on its tributaries has one or more possibilities for storage reservoirs, a number of which have already been developed. The principal storage developments already in operation are those of the Southern Power Co. on the headwaters of Catawba River, with a storage capacity of 13,500,000,000 cu.ft. and Georgia Railway & Power Co. on the Tallulah River, one at Burtón with 5,280,000,000 cu.ft. and one at Mathis containing 1,369,000,000 cu.ft. of storage.

The Alabama Power Co. has now in course of development a storage project on the Tallapoosa River at Cherokee Bluffs that will, when completed, have a storage capacity of 60,000,000,000 cu.ft. and will be able to develop approximately 136,000,000 kilowatt-hours.

The majority of the southern hydro-electric plants are low-head developments with the exception of the Tallulah Plant of the Georgia Railway & Power Co. on the Tallulah River, which has a head of 600 ft. and the Ocoee Plant of the Tennessee Power Co. on the Ocoee River, with a head of 254 ft. These can be classed as medium high-head developments.

*Abstract from a paper by O. G. Thurlow and J. A. Sirnit, both of the Alabama Power Co., presented at the Spring Convention of the American Institute of Electrical Engineers, held in Birmingham, Ala., April 7 to 10.

While the proposed Eastern superpower zone is still under discussion, a virtual superpower system has been in existence in the South for several years, covering the states of Alabama, Georgia, Tennessee, North and South Carolina. The Southern zone consists of the interconnected system of seven independent companies: Alabama Power Co., Columbus Power Co., Georgia Railway & Power Co., Central Georgia Power Co., Tennessee Power Co., Southern Power Co. and Carolina Power & Light Co. The interconnected system forms a network over a territory approximately 600 miles long, and 300 miles wide at its greatest width. All large plants, hydro and steam, are connected to this system with an aggregate capacity of about 1,100,900 kilowatts.

The table shows the various plants with their capacities of the different power companies, that are either in operation or will be in the near future.

POWER GENERATING STATIONS OF THE POWER COMPANIES IN THE SOUTHEAST

Hydro-Electric Stations, Kw.		Steam-Electric Stations, Kw.	
Alabama Power Company			
Lock 12.....	81,000	Warrior.....	70,000
Mitchell Dam...	60,000	Gadsden.....	10,000
		Birmingham...	8,000
		Montgomery...	5,000
		Sheffield*.....	60,000
Total.....	141,000	Total.....	153,000
Tennessee Power Company			
Hales Bar.....	43,300	Parksville.....	13,000
Parksville.....	18,650	Nashville.....	29,600
Great Falls.....	7,800	Knoxville.....	6,250
Ocoee No. 2....	18,750	Hales Bar†	20,000
Total.....	88,500	Total.....	68,850
Georgia Railway & Power Company			
Tallulah Falls...	72,000	Atlanta, Butler Street.....	7,800
Morgan Falls...	21,000		
Tulago.....	50,000	Atlanta, Davis Street.....	11,750
Dunlap.....	2,200		
Chestater.....	900		
Total.....	146,100	Total.....	19,550
Columbus Electric & Power Company			
Goat Rock.....	17,500	Columbus, Ga..	9,000
North Highland	6,900		
Total.....	24,400	Total.....	9,000
Central of Georgia Power Company			
Lloyd Shoals....	18,000	Macon.....	3,000
Southern Power Company			
Bridgewater....	20,000	Eno.....	25,000
Lookout.....	18,000	Greensboro.....	6,800
Catawba.....	4,800	Mount Holly...	36,800
Fishing Creek...	30,000	Greenville.....	6,800
Mountain Island	60,000		
Great Falls.....	24,000		
Rocky Creek...	24,000		
Wateree.....	56,000		
Dearborn.....	45,000		
Ninety-nine Islands.....	18,000		
Total.....	299,800	Total.....	75,400
Carolina Power & Light Company			
Buckhorn.....	2,900	Florence.....	1,500
Blewett.....	30,000	Raleigh.....	3,720
		Goldsboro.....	1,200
		Cape Fear.....	15,000
Total.....	32,900	Total.....	21,420
Total hydro-electric.....	750,700	Total steam-electric.....	350,220

* Leased from United States government.
† June, 1924.

The main trunk line is over 800 miles long with several thousand miles of branch lines connected to it. The interconnection of these systems was accomplished by the building of tie lines and the installation of sufficient transformer and switching capacity at the tie-in points to take care of the exchanged energy. Few changes had to be made in the individual systems themselves, as, fortunately, all the companies involved had already standardized on a frequency of 60 cycles and most of them operated their principal transmission lines at 110,000 volts.

Although energy has been transmitted a distance of about 600 miles on this interconnected system, the use of high-voltage trunk lines of the order of 220,000 volts has not been found necessary. It is obvious, of course, that no great bulk of power could be directly transmitted a distance of 800 miles at 110,000 volts, but by a process of relaying the energy from generating stations to adjacent load centers, the same benefits have been accomplished. For instance, assume that the Carolina Power & Light Co. at the extreme northeastern end of the interconnected system desires to secure a block of power which is to be supplied by the Alabama Power Co. The latter company delivers the required amount of power to the Georgia Railway & Power Co. at the Georgia-Alabama state line, which will be absorbed on the Georgia system in that vicinity. The Georgia Railway & Power Co. will then transmit energy from its Tallulah Falls Plant, at the other extreme end of its system, to the Southern Power Co. This company will in turn absorb this energy locally and transmit a like amount from generating stations in the vicinity of the tie point of the Carolina Power & Light Co. The systems, relaying the energy, of course, deduct an amount sufficient to cover transmission losses, costs of transmission, etc.

Heat-Transfer Symposium at Washington

Studies of loss of heat from furnace walls and from steam pipes were among the most interesting reports which were submitted at the Heat Transfer Symposium of the Division of Industrial and Engineering Chemistry, during the sixty-seventh meeting of the American Chemical Society at Washington. A number of technical papers were read, with stereopticon illustrations, and discussed by various members during the sessions. Dr. W. H. McAdams, of the Massachusetts Institute of Technology, presided as chairman of the symposium. D. H. Sperry is chairman and E. M. Billings is secretary of the Division.

Heat losses by the industries of the United States are equivalent to fuel costing approximately $1,000,000,000 annually, it was declared in a report on a nation-wide survey made by Robert Calvert and Lyle Caldwell, of the Celite Products Co., and presented by Mr. Calvert.

Speaking of economies of heat insulation, the report stated that the insulated wall loses only about 40 per cent as much heat as the uninsulated wall and that savings through insulation aggregate approximately 250 tons of coal a year for 1,000 sq.ft. of wall surface.

A highly technical paper on the forced convection of heat in gases and liquids was presented by Chester W.

Rice, of the General Electric Co. in which the problem was studied from the point of view of the film theory. Another mathematical paper, although of a simpler nature than that of Mr. Rice, dealt with the optimum operating conditions for pipe heating and cooling equipment. This was presented by W. K. Lewis, J. T. Ward and E. Voss, of the Massachusetts Institute of Technology.

A paper by L. A. Pridgeon and W. L. Badger outlined experiments in evaporator design carried on in the evaporator experiment station at the University of Michigan, while W. L. McCabe and Clark S. Robinson, of the Massachusetts Institute of Technology, gave an analysis of scale formation in evaporators. D. K. Dean, of the Alberger Pump & Condenser Co., applied the film concept of heat transmission to a commercial water heater.

R. H. Heilman, of the Mellon Institute of Industrial Research, Pittsburgh, in a paper on "Heat Transmission from Bare and Insulated Pipes," gave the results of a number of tests on bare pipes of various sizes, showing the loss in dollars and cents. The results obtained with various types and thicknesses of coverings for pipes as determined by tests at the Institute also were presented.

Declaring that while many studies of heat transfer have been made, most of these have been with the idea of meeting a special problem and that little fundamental data applicable to heat engineering as a whole have been correlated, W. H. Carrier, representing the National Research Council, told the engineers that this organization has appointed a committee to conduct a study of fundamentals, which it is hoped within a few years will be sufficient to warrant general conclusions.

Comments Desired on Proposed Standard Smoke Ordinance

Helpful criticism and suggestions are desired by the committee that has prepared this proposed ordinance. The committee represents the American Society of Heating and Ventilating Engineers, the Stoker Manufacturers' Association, American Civic Association, and the Fuels Division of the A. S. M. E. Correspondence should be mailed to Dr. O. P. Hood, Bureau of Mines, Washington, D. C.

The first two sections of this ordinance take up the subject of the creation of the Bureau of Smoke Regulation and its relation to city government. In addition an advisory board is to be appointed which will act as a board of appeal and shall consist of qualified engineers. The emission of smoke is to be judged by Ringlemann Charts, as given in Section 3.

"Sec. 3. The production or emission within the city of smoke, the density or shade of which is equal to or greater than No. 3 of the Ringlemann Chart, from any stack, except that of a locomotive or steamboat, for a period or for periods aggregating two minutes or more in any period of fifteen minutes, and the emission of such smoke from any locomotive or steamboat for a period or for periods aggregating one minute or more in any period of eight minutes, is hereby prohibited."

Penalties are liberally provided not only for those who infringe, but also for members of the Bureau who need disciplinary measures. Permits are required for all construction, installation and repair work.

Boiler settings and equipment are provided for in section 10, from which the following is quoted:

"Sec. 10. (a) Each power boiler with more than 1,500 sq.ft. of heating surface, using coal as fuel, shall be provided with a mechanical stoker or other device or attachment approved by the Bureau of Smoke Regulation.

"Heating surface shall be construed to mean all boiler surfaces in contact with hot gases.

"(b) The minimum distance between dead plate and boiler shell for horizontal return-tubular boilers shall be not less than the following, according to diameter of boiler:

Diameter of Boiler, Inches	Distance from Dead Plate to Shell, Inches
48 and less	30
54	32
60	34
66	34
72	36
78	38
84	38

In most cases it is desirable to have more than this minimum.

"(c) Where it is proposed to use oil or powdered coal as fuel for horizontal return-tubular boilers, the height of the boiler shell above the ash pit shall be not less than 60 inches; in most cases more is desirable.

"(d) All hand-fired furnaces for stationary boilers carrying more than ... pounds steam pressure shall be provided with steam-air jets or other approved method of admitting auxiliary air above the grates.

"If steam-air jets are used, there shall be one such jet for each 250 sq.ft. of heating surface or fraction thereof, and the minimum number of steam-air jets shall be three.

"(e) Boilers carrying not to exceed[1] ..... pounds steam pressure shall be provided with openings to admit auxiliary air above the fuel bed, having a free air opening of not less than 3 sq.in. for each square foot of grate surface.

"(f) All return-tubular boiler settings, in addition to steam-air jets and auxiliary air openings, shall have such gas-mixing arches, piers or other devices as are acceptable to the Bureau of Smoke Regulation.

"(g) Full extension furnaces shall be used on all stationary hand-fired vertical fire-tube boilers. The arch of the extension furnace must extend 4 ft. behind the grate.

"(h) Each hand-fired water-tube boiler of the highly inclined or vertical type shall have full extension furnace with an arch extending at least 4 feet back of the grate and firebrick piers or other acceptable construction installed.

"(i) Each chain-grate stoker shall have an ignition arch with minimum length[2] equal to ..... of the length of active grate.

"(j) Side inclined and front overfeed stokers installed under vertically baffled boilers may be set with flush front provided the minimum distance from grate surface to heating surface is 7½ ft. If minimum distance is less than 7½ ft., a full extension furnace, with arch extending 2 ft. back of the grate, shall be used.

"(k) Where side inclined and front overfeed stokers are installed under horizontal return-tubular boilers, full extension settings shall be used.

"(l) Portable boilers of the vertical or locomotive type shall use "smokeless" fuel, unless such boilers are equipped with approved smoke-preventing devices which will insure 'smokeless' operation under normal working conditions."

Low-pressure boilers are limited to a definite amount of steam pressure, as governed by conditions in the various states. Those rated at 2,000 sq.ft. or more of steam radiation or 3,000 sq.ft. of water radiation shall be of a satisfactory "smokeless" type, to operate as governed by Ringlemann's tests.

Low-pressure boilers below 2,000 sq.ft. of steam radiation or 3,000 sq.ft. of water radiation, and hot-air furnaces with more than 9 sq.ft. of grate surface, if not of a satisfactory "smokeless" type, shall burn only "smokeless" fuel.

The projected grate area of any boiler using coal as fuel shall be not less than 1/60 of the heating surface where stokers are used, and 1/45 of the heating surface in hand-fired furnaces.

Kent's formula as published in the Transactions, A. S. M. E., vol. 6, page 81, and also given in handbook, may be used to determine the size of the stack. For each right-angle bend in the breeching 10 ft. shall be added to the height so determined. The height of the stack shall be at least thirty times its inside dimension when the height does not exceed 65 feet.

Stack heights and details of installation of such boilers are covered in the few remaining sections of these ordinances.

"(w) No stack to which a 'smokeless' boiler (2,000 sq.ft. or more capacity steam radiation or 3,000 sq.ft. or more capacity water radiation) is attached shall be less than 50 ft. high above the center of the breeching connection to the stack.

"(x) The inside walls of the stack shall be smoke-tight, vertical, free from offsets, constrictions or enlargements, and shall have no openings between the breeching and the top of the stack.

"(y) The top of the stack shall extend above or be far enough away from any nearby building to avoid downdrafts.

"(z) The minimum setting heights of boilers shall be those recommended by the Stoker Manufacturers' Association and the Boiler Manufacturers Association in 1922."

[1] This will vary according to location. As a matter of fact, the minimum pressure at which steam-air jets are really effective is about 60 pounds.

[2] In the Illinois district it is the judgment of chain-grate engineers that this minimum should be $\frac{2}{3}$ and that in no case should the length of arch be less than 5 ft. Further east $\frac{1}{2}$ may be sufficient.)

Committee of the American Engineering Council Reports on Muscle Shoals

Advocates Joint Committee of Congress Consider Offers—Disposition of Power Plants Accord with Water Power Act

NO DISPOSITION should be made of the Government's Muscle Shoals properties until a joint committee of Congress, as recommended by the President in his message of Dec. 6, shall have considered all offers and have made a report. The power project should be conducted under the provisions of the Water Power Act. These are the recommendations of the Committee of American Engineering Council, headed by F. R. Low, the president of the American Society of Mechanical Engineers.

FINDINGS OF THE COMMITTEE

The findings of the Low committee are indorsed by the administrative board of American Engineering Council. Governor Hartness, in his capacity as president of the Council, on April 28 dispatched the following letter to Senator Norris, the chairman of the Senate Committee on Agriculture, which is considering the bill proposing to accept the Ford offer for Muscle Shoals:

"Pursuant to your request under date of April 5, 1924, relative to the Muscle Shoals situation, the American Engineering Council appointed a committee to examine the available data and facts and report thereupon. The committee so appointed found it impossible in the time available and with the means at its command, to sift out from the mass of conflicting testimony and information, sufficient undisputed and determinable data upon which to base a sound engineering recommendation as to the disposition or use of the property.

"The committee was, however, unanimously agreed:

"First, that a Joint Committee of Congress should be constituted 'to consider offers, conduct negotiations and report definite recommendations' as advised by the President in his message to Congress delivered Dec. 6, 1923.

"Second, that no disposal should be made of any of the Muscle Shoals properties or rights until such Joint Committee of Congress shall have rendered its report.

"Third, that in no event should any disposition be made of the power plants which is not in substantial accord with the provisions of the Federal Water Power Act.

"In the course of its investigations the committee found nothing to justify the popular belief that the operation of the existing plants at Muscle Shoals will make substantially cheaper fertilizers immediately available, inasmuch as nitrates, however important, constitute but one of the three basic ingredients of commercial fertilizers, and consequently a considerable reduction in the nitrate cost would be reflected only to a slight degree in the cost of the marketable product.

"The committee further found that recent developments of the synthetic process of nitrogen fixation had materially changed the entire outlook in the art and it is now quite possible that this process, for the use of which the so far unsuccessful Muscle Shoals Plant No. 1 was designed, may yet yield nitrate at a cost to compete with that obtained from Chile; and Plant No. 1, until recently considered a failure, may be the more valuable of the two constructed by the government for the purpose intended.

"The Administrative Board of the American Engineering Council has carefully reviewed the work of its committee and indorses the findings and recommendations above set forth; and in view of the great importance of the questions involved and the much apparently contradictory information thereon presented, to the Congress and to the public, the said Board would recommend and as far as propriety permits would urge that no disposition of the plants be decided upon until a thorough investigation can be made by a disinterested technical commission, and the Board hereby tenders its services to assist in the formation of such a commission if and whenever such assistance may be desired."

Mead Indorses Public Control of Colorado

"The Boulder Dam project is financially feasible, an industrial and agricultural necessity, better adapted to unit development under public control than piecemeal methods by private ownership," said Commissioner of the Bureau of Reclamation, Dr. Elwood Mead, according to the *Christian Science Monitor*. Dr. Mead, considered an authority on land colonization and irrigation, is an exponent of public ownership. He was connected with the survey of the All-American canal to the Imperial Valley and believes "the greatest remaining public utilities in the West," the Colorado River project, should be preserved from speculators.

President Dedicates Academy of Sciences Building

At the annual meeting of the National Academy of Sciences, held in Washington, D. C., the new building at B and Twenty-first St., was dedicated on April 28. Exercises were held in the morning, at which the President was the principal speaker.

President Coolidge, in his dedicatory address, traced the intimate relationships which from the days of Benjamin Franklin have existed between science and the American government, and declared that "If there be one thing in which America is pre-eminent it is the disposition to follow the truth."

A. A. Michelson, president, John G. Merriman, vice-president, Vernon Kellogg and Gano Dunn also spoke.

In the late afternoon the ceremony of assigning a room to the Engineering Foundation in token of appreciation of the assistance rendered by the Engineering Foundation to the National Academy of Sciences in the establishment of the National Research Council took place.

Production of Bituminous Coal in the United States 1924-1918

In Thousand Net Tons

	1924	1923	1922	1921	1920	1919	1918
January	50,801	50,178	37,489	41,148	49,748	42,193	42,227
February	45,725	42,160	40,856	31,524	41,055	32,103	43,777
March	.....	46,802	49,976	31,054	47,850	34,293	48,113
April	.....	42,564	16,000	28,154	38,764	32,712	46,041
May	.....	46,076	20,601	34,057	39,841	38,186	50,443
June	.....	45,490	22,624	34,635	46,095	37,685	51,138
July	.....	45,126	17,147	31,047	45,988	43,425	54,971
August	.....	48,864	27,538	35,291	49,974	43,613	55,114
September	.....	42,216	39,413	35,870	50,241	48,209	51,183
October	.....	49,177	44,907	44,687	53,278	57,200	52,300
November	.....	42,911	45,103	36,805	52,576	19,006	43,895
December	.....	39,836	46,240	31,650	53,257	37,235	40,184
Total	.....	545,400	407,894	415,922	568,667	465,860	579,386

Source—Geological Survey. Monthly figures for years prior to 1922 have been scaled up to meet the total of the annual canvass of mines, whereas the figures for 1922, 1923 and 1924 are preliminary estimates based on reports from the railroads.

Tentative Code for Blower and Exhaust Systems

The National Fire Protection Association, 40 Central St., Boston, Mass., which is holding its annual meeting at Atlantic City, May 13-15, is sending out advance copies of the Report of the Committee on Blower Systems, for heating, ventilating, stock and refuse conveying. The report presents a tentative code for "The Regulations for the Installation of Blower and Exhaust Systems: (1) Heating and Ventilating Systems; (2) Systems for Removal of Flammable Vapors; (3) Stock and Refuse Conveying Systems." The code has not yet been considered by the association and is subject to change before final adoption.

Floating Power Plant for Large Sawmill

Urgent demands for additional electric service during the construction of the Long-Bell Lumber Company's manufacturing site at Longview, Wash., about 50 miles below Portland, Ore., led the company to build a temporary power plant on barges (briefly described in *Power*, Jan. 8, 1924) for use until the 20,000-kw. permanent plant in the mill could be completed. To have placed the temporary plant on shore would have required that it be at least 35 ft. above low water, and this, together with the elements of cost and time, led to the adoption of the idea of a floating plant. The installation consists of one 1,500-kw. turbine and three 250-hp. boilers, two of them of the locomotive type. Within twenty-eight days after the decision was reached as to the type of plant, it was completed and in operation. A fuel tank on the barge is connected by means of a hose with a storage tank on shore, and the barge is anchored in the Columbia River convenient for oil supply and connection to the electric distribution lines on shore.

Care had to be taken in mooring the barge so that it would not be affected by the waves from passing steamers. In order to make sure of ample protection from rolling, the barge was fitted with heavy log outriggers on each side and a log boom was drawn around it to minimize the wave action.

Rochester Gas & Electric's Future Plans

Four hydro-electric plants on the Genesee River and a new steam station will probably be built and in operation by the Rochester Gas & Electric Corp. in the next twenty years, according to the yearbook of that utility, recently issued. The present question, says the company, is to determine which of these plants shall be the first undertaken. Six considerations will govern: Cost of coal; possibilities of the mercury turbine and the hoped-for internal-combustion turbine; cost of capital; cost of materials and labor; market for exhaust steam for industrial heating; the possibilities of the purchase of reasonable energy when made available from the St. Lawrence and from further development at Niagara.

Consumers Should Order Their Coal Now

With hearings in progress before the Interstate Commerce Commission on the Lake cargo rate case; with mine rating and card distribution rules about to be taken up for the consideration of proposed revisions and with Section 28 of the Merchant Marine Act under debate on Capitol Hill, matters involved in the transportation of coal promise to be on the tapis for some time to come. In addition strong influences are at work in an effort to spread the coal movement as evenly over 1924 as was the case in 1923. *Railway Age* is alarmed by the recent abnormal decline in coal shipments and declares editorially that if "the present low rate of production continues, there later will be an abnormal increase in production and in demands upon the railways for transportation. This abnormal increase in the demands upon the railways will cause congestion in the handling of all traffic and abnormal and unnecessary operating expenses that the shipping public will have to pay."

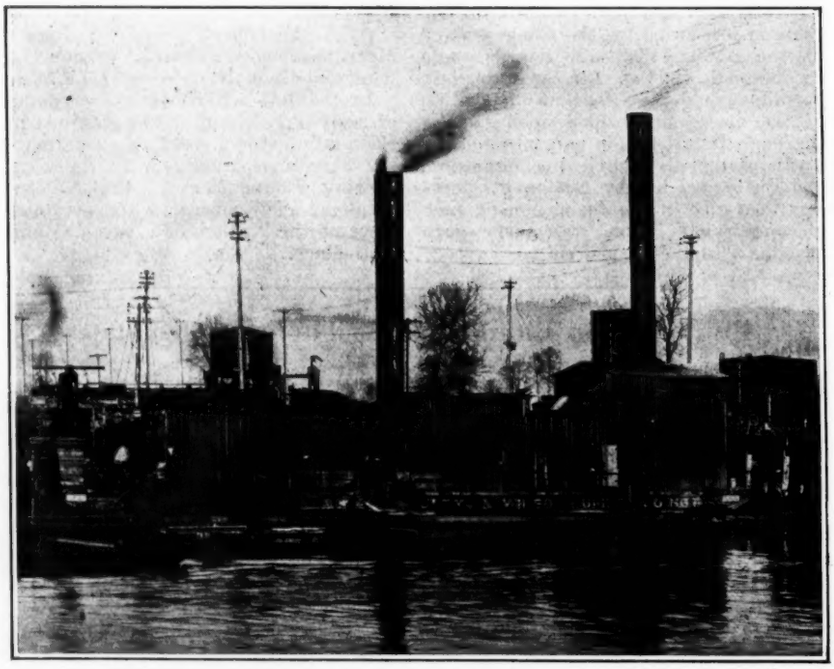
There has been no time in a decade that the producers of coal would rather ship than at present. If some means can be devised to convince consumers that they should make purchases at this time, the producers would be as pleased as would the railroads were it possible to put into immediate service the 200,000 coal cars now standing indle.

Italy Is Planning Many New Plants

Conditions in Italy during 1923 were generally favorable to the electric power industry according to a report recently made by the Director of the Association of Electric Power Companies. In contrast to 1921-22 the rainfall was satisfactory, while new plants were put into service, agreements with regard to exchange of current were made and technical improvements in the transmission lines were effected.

Statistics compiled by the Association of Electric Power Companies show 16 new reservoirs having a capacity of 340,475,000 cu.m. in construction which will be completed by 1927 and 15 additional reservoirs with a capacity of 682,000,000 cu.m. planned.

Twenty-four power plants rated at 824,140 kva. are under construction and will be completed by 1932, while 56 additional plants rated at 1,571,200 kva. have been planned.



Floating power plant used during construction work

Rochester Students Test Industrial Plants

The Industrial Management Council of the Rochester Chamber of Commerce has been working in co-operation with the department of mechanical engineering of the University of Rochester in making power-plant tests in the industrial establishments of the City of Rochester.

The tests are being made by the senior students, under actual operating conditions, supervised by the staff of professors of the mechanical engineering department; the department supplying the apparatus. The tests are for as long as the load period of the plant will permit and are quite complete. They include sampling and analysis of coal, flue-gas analysis, etc., and conform as closely as possible in every detail to the A.S.M.E. Code. As no two plants are exactly alike, the work offers many interesting problems.

This contact of students with actual plant conditions and the experience in changing operating methods to bring about more efficient use of fuel should be not only a most important thing for the student, but a great help to the industries of the city.

Condenser Tube Standards To Be Discussed

Further steps toward the efficient development of marine engineering practice will be taken on May 5, when a meeting will be held in the Division of Simplified Practice, Department of Commerce, to consider standard specifications for condenser tubes and ferrule stock. Representatives of power plants in addition to marine interests have been asked to participate. The American Marine Standards Committee in co-operation with the Federal Specifications Board and the American Society for Testing Materials will assist the Commerce department in the program.

Allis-Chalmers Buys Cudahy Plant of Worthington Pump

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., has acquired the machinery and business of the Cudahy plant of the Worthington Pump & Machinery Corp. in Wisconsin. The building and real estate are not included in the sale, and it is understood the price paid was less than a million dollars.

The plant produces power and mining machinery in which Allis-Chalmers specializes. It is said that the action of the Worthington interests in disposing of the machinery and good will of this business was in line with the company's policy to concentrate on specialized lines.

The Cudahy plant will be closed, and the departments other than those sold to Allis-Chalmers will be transferred to the larger plants of the Worthington company.

Ford Motor Company Builds Individual Power Plants

The Ford Motor Co., Highland Park, Detroit, Mich., will construct individual power stations at each of its eight assembling plants projected in different parts of the country, as well as its proposed new factory at London, Eng.

Each station will be provided with steam turbo-generators and accessory equipment for complete light and power service at the particular plant. The different assembling works will represent an investment of close to $5,000,000, and include the following, of which a number have now been started: St. Paul, Minn., capacity 750 cars per day; Chicago, Ill., 600 cars per day; Memphis, Tenn., 300 cars per day; Charlotte, N. C., 300 cars daily; Jacksonville, Fla., 150 cars per day; Louisville, Ky., 300 cars daily; Kansas City Mo., addition, 250 cars, making a total of 500 cars daily for the plant; Oklahoma City, Okla., addition, 50 cars, making a total of 200 cars; and new assembling works, for which contract is about to be let, at Norfolk, Va., 250 cars. The proposed London factory will cost in excess of $750,000, and is not included in the above noted gross cost.

The Ford company has organized a subsidiary, to be known as the Ford Hydro-electric Power Co., with the intention of constructing a hydro-electric generating plant on the Menominee River in Wisconsin.

Noted Research Engineer Dies in St. Louis

Alfred Cotton, Chief Research Engineer of the Heine Boiler Co., who died at his home in St. Louis on April 17, was born in Southport, England, Nov. 30, 1871. While serving an apprenticeship from 1885 to 1892 in marine engineering, he received his technical education through university-extension courses and by private tuition. He was then engaged by Thomas Henderson, of Liverpool, for whom he worked in designing mechanical stokers and grates until 1894, when he entered the Port Sunlight Soap Works of Lever Brothers, Ltd., as engineering assistant to the works manager. Here he designed one of the first, if not the first, double-stage centrifugal pumps, which operated with fairly high efficiency and entire satisfaction.

Alfred Cotton

In 1898 Mr. Cotton became assistant chief engineer for Meldrum Brothers, Ltd., working on the design and adaptation of mechanical stokers and forced draft, and collaborating in the development of destructors for generating steam from municipal refuse. He came to America in 1903 and developed the Cotton furnace, which embodied a high-efficiency system of steam-jet forced draft. He manufactured and installed these furnaces and allied apparatus until the war, when he entered the employ of Colt's Patent Fire Arms Manufacturing Co., designing jigs, fixtures and tools for the production of the Browning machine gun. In 1918 he became chief engineer in the combustion department of the Sterling Blower Co.

Mr. Cotton went to St. Louis about five years ago as research engineer of the Heine Boiler Co. Many of that company's developments have been due to his ingenuity and broad knowledge of engineering principles. He was of an inventive turn of mind and had many ingenious and original ideas, to cover which a number of patents have been issued, others applied for, and still more on which applications have yet to be made. His death was untimely and he will be greatly missed by all.

A.S.H.&V.E. Meets at Kansas City, June 10

The American Society of Heating and Ventilating Engineers will have several sessions and papers of interest to *Power* readers on the program of its summer meeting to be held at Kansas City, June 10-11.

Five sessions will be devoted to the discussion of the "Code of Minimum Requirements for the Heating and Ventilation of Buildings"; "Effective Temperature Applied to Industrial Ventilation Problems," by C. P. Yagloglou and W. E. Miller; "The Flow of Steam and Condensation as Affected by High Pressures, Horizontal Offsets and Valves," by Louis Eben and R. L. Lincoln; "Practical Applications of the Heat-Flow Meter," by P. Nicholls.

International Conference of Women Engineers

The Second International Conference of Women's Engineering Societies was held recently in Manchester, England. About forty delegates including representatives from America and Belgium, were welcomed by the Lady Mayoress. Two technical papers were read to the conference on the first day, "Heavy Oil Engines," by Miss V. Holmes and "Resistance Welding," by Mrs. McBerty the American delegate. "Alternating Motors," by Mlle. Massart, the Belgium delegate, and visits to the College of Technology, a famous Manchester spinning mill and an engineering firm were part of the program of the second day. The president of the Woman's Engineering Society, the Hon. Lady Parsons, delivered a presidential address that dealt with some of the outstanding engineering achievements of the year.

Byllesby Dies Suddenly in Chicago

Henry Mallison Byllesby, head of the bond and engineering house bearing his name, nationally known promoter of public utilities and at one time a co-experimenter with Thomas Edison, died suddenly on May 1 of heart disease. He was stricken in his dentist's office, and although a heart specialist was hastily called, Mr. Byllesby died before he arrived. He had been afflicted with heart disease for many years.

In addition to being president of H. M. Byllesby & Co., Mr. Byllesby was an officer and director in a number of public utilities companies all over the United States and was a member of the A.S.C.E. and A.S.M.E.

He served during the war as general purchasing agent for the A.E.F. and was stationed at London. For his services he was honored by the British government with the Distinguished Service Order and by the American government with the American Distinguished Service Medal.

Mr. Byllesby was 65 years old and is survived only by his widow.

South Africa to Have Cheap Power

Lower power rates during the next 20 years have been obtained by the Rand mining industry, as the outcome of recent negotiations with the Victoria Falls Power Co. The new arrangement will be partly retroactive to Jan. 1, 1923, although the full benefit of it will not go into operation until the new Witbank station is completed. Experts believe that power will be produced at a lower cost at Witbank than at any other power station in the world, according to Assistant Trade Commissioner William E. Vaughan, Jr., Johannesburg, South Africa.

Canadian Water Power Resources Reviewed

The report of the Dominion Water Power Branch of the Department of the Interior of Canada, "Water Power Resources of Canada," has just been issued. It states that there has been an increase during 1923 of over a quarter of a million horsepower and that the total hydraulic power installations of Canada has now reached the imposing total of 3,227,414, while the growing demand for power is demonstrated by the numerous large developments being rapidly pushed to completion. These new developments are not confined to any particular section of the country, but extend from coast to coast and are designed to serve practically every community where a demand for power exists.

The known available water power in Canada from all sources and within certain limitations outlined, is 18,255,000 hp. for conditions of ordinary minimum flow and 32,076,000 hp. under a flow estimated for maximum development that is dependable for at least 6 months of the year.

The 3,227,414 hp. at present installed in this country may be classified as follows: 2,411,701 hp. in central stations for general distribution for all purposes; 497,620 hp. installed in pulp and paper mills not including 228,755 hp. purchased by pulp and paper companies from central stations; 318,093 hp. installed in industries other than central stations and pulp and paper mills. The total installation for the Dominion averages 353 hp. per thousand population, a figure that places Canada third in the per capita utilization of water power among the countries of the world, Norway and Switzerland only having a higher per capita utilization.

The growth of water-power developments in Canada has been striking. Total installed horsepower has grown from 975,000 to 3,227,000 since 1910, central installation from 605,000 hp. to 2,411,701 hp. and pulp and paper installation from 191,000 to 498,000 hp.

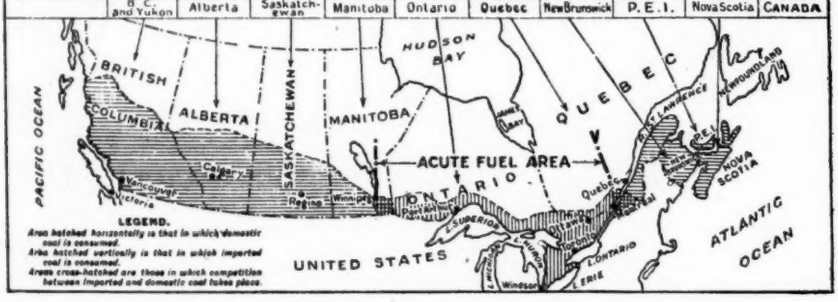
All the modern tendencies in the utilization of cheap power indicate that the rate of growth of hydro-electric development in Canada will increase rather than lessen. Should the rate of installations since 1910 be maintained at its present rate there will be installed in 1925 4,000,000 hp., in 1930 5,000,000 hp., in 1935 6,000,000 hp. and in 1940 7,000,000. These growth figures are considered conservative as the rate of growth since 1920 has been considerably in excess of the rate over the whole period from 1910. Available reserves are more than ample to take care of these future demands, as outlined, for a long time to come. The water power now developed in Canada represents an investment of over $687,000,000. In 1940 should the rate of growth in installations during the last fifteen years be continued, this investment will have grown to over $1,500,000,000. The present development represents an annual equivalent of 29,000,000 tons of coal, which, valued at $10 per ton, represents $290,000,000. In the year 1940 these annual figures will, with the foregoing assumption, have become 63,000,000 tons and $630,000,000.

Copies of the bulletin "The Utilization of Water Power in Canada in Relation to Coal Production, Importation and Consumption," can be had free of charge from the Director of Water Power, Ottawa, Canada.

THE COAL SITUATION IN CANADA, 1923

PRELIMINARY FIGURES. SHORT TONS

	B.C. and Yukon	Alberta	Saskatchewan	Manitoba	Ontario	Quebec	New Brunswick	P.E.I.	Nova Scotia	CANADA
Output	2823,317	6,848,538	439,892	—	Acute Fuel Area		276,603	—	6,595,672	16,984,022
Other provinces										
Received from	108,676	18,054	1,249,549	785,314	80 755	1,540,283	561,258	80,916	—	4,424,805
Shipped to	62,151	1,933,144	222,478	—	—	—	32,112	—	2 175,220	4,424,805
Exports (1)	838,063	605	11,510	8,213	877	3	115,364	—	679,771	1,654,406
Imports (2)	20,429	1,110	3,898	167,990	17,212,768	4 976,898	192,625	5,566	106,036	22,687,320
Consumption (4)	2,052,208	4,933,953	1,459,651	945,091	17,292,646	6,517,178	883,010	86,482	3,846,717	38,016,936
Foreign imports in % of consumption	0.01%		0.03%	17.8%	99.8%	76.4%	21.8%	6.4%	2.7%	60%
Coal equivalent of developed water power (annual) (5)	3,318,000	298,000		1,458,000	13,009,000	10,058,000	401,000	20,200	492,000	29,554,000



Prepared in Dominion Water Power Branch, Department of Interior, Canada

Water-Power Projects

Colorado River—James B. Girand has withdrawn his construction force from his project at Diamond Creek.

Baker River Project. — The Puget Sound Power & Light Co., of Seattle, has declared its intention to construct a dam 210 ft. high in the Baker River, a tributary of the Skagit. The company plans to install machinery capable of generating 20,000 hp. As navigation is not thought to be affected by this development, it is probable that the Federal Power Commission will not take jurisdiction.

Snake River Project—A preliminary permit has been authorized by the Federal Power Commission for the Idaho Power Co. covering a project on Snake River at Twin Falls. The Idaho company applied for this permit July 7, 1920. Action has been withheld at the request of the Bureau of Reclamation. Developments in connection with the location of the American Falls reservoir are such that the Bureau has withdrawn its objection.

Wallenpaupack River — The Pennsylvania Power and Light Co. has applied to the Federal Power Commission for a license covering its project on the Wallenpaupack River in northwestern Pennsylvania. The application shows that the company plans to construct a reservoir to store 160,000 acre-feet of water. A pipe line, developing a head of 300 ft., will lead from the reservoir to the powerhouse on the Lackawaxen, where 54,000 hp. will be developed. That plant is to be connected with the company's existing steam plant and will provide the peak power for its system in the Allentown region.

Oregon Rivers—An investigation of the power possibilities of Smith, Trask and Nestucca Rivers, Oregon, has recently been made by an engineer of the Geological Survey. It was found that the total potential power with regulated flow on Trask, Nestucca and Smith Rivers amounts to 21,600 hp. for 90 per cent of the time and 47,700 hp. for 50 per cent of the time. No exceptionally good power sites were found. A brief illustrated report has been prepared and a manuscript copy of this may be consulted at the Geological Survey office, Interior Bldg., Washington, D. C. or at room 606 P. O. Bldg., Portland, Ore.

St. Croix River.—Surveys have been completed and plans are under design for the two new water-power plants for the Northern States Power Co. on the St. Croix River. One of these will be built at Kettle River Rapids, about 40 miles above St. Croix Falls. The head here will be about 80 ft. and the installed capacity about 40,000 hp., and the construction will involve an expenditure of more than $5,000,000. The second plant will be nearer St. Croix Falls. It will have an ultimate developed head of about 105 ft. and will involve an expenditure of approximately $3,000,000. Surveys on the two Mississipi River sites at Monticello and Otsego have been nearly completed, and plans will be immediately worked out for submission to the Federal Power Commission.

The total expenditure involved in these two developments will be in the neighborhood of $10,000,000.

Sultan River, Wash., Project—The Sound Power Co., of New York, which has been interested for many years in a proposed development on the Sultan River near Everett, Wash., and which holds a preliminary permit covering the site, has filed an application for license with the Federal Power Commission. The company states that it is ready to proceed with construction. An upper project capable of developing 65,000 hp. and a lower project capable of developing 80,000 hp. are planned. The applicant expects to find an industrial market for most of its power. The power will be used chiefly in pulp and paper manufacture and in connection with forest products industries. The company expects to make the development so that the cost will not exceed $90 per installed horsepower. This project is of particular interest because it is one of the few that are not being put forward as an extension of an existing public utility. Like the Priest Rapids development on the Columbia and that of the Columbia Valley Power Co. on the Deschutes, the project involves the creation of an entire new market.

Society Affairs

The Chicago Section of the Association of Iron and Steel Electrical Engineers will have presented at its May 16 meeting a paper by Mr. Jamieson, of the Commonwealth Edison Co., on "Large Power Stations of the Commonwealth Edison Co."

The Greenville N. C., Section A.S.M.E. will hold its May 10 meeting at Canton, N. C. "Making Cast Iron Pipes by de Lavand Process" will be the topic of the meeting. Charles E. Oakes, of the Federal Power Commission, is expected to speak.

The Cleveland Safety Council, Society of Ohio Safety Engineers and the **Engineering Section of the National Safety Council** will hold a safety conference in Cleveland on May 16. The general topics to be discussed are "Legislation and Codes," and "Plant Housekeeping."

The Roanoke, Va., Section of the A.S.M.E. will hold an all-day meeting on May 9. Papers will be given as follows: "Development and Distribution of Power for Industrial Purposes," by A. H. Grimsley; "Reclamation of Waste in Industry," Mr. Mount, of Lynchburg, Va.; "Use of Coal at Mines"; "Air Reduction Sales Co., Liquid Air," illustrated by moving pictures.

The Baltimore Section of the A.S.M.E., at its May 6 meeting, will hear papers on "Design and Construction of 13,200-Volt Switchhouse," and "Installation of Two New 20,000-Kw. Hydraulic Turbines," by A. S. Loizeaux and A. L. Penniman, Jr., of the Consolidated Gas, Electric Light & Power Co. There will also be an inspection trip to the Westport power station. This meeting was formerly announced for April 26.

Coming Conventions

American Association of Engineers. C. E. Drayer, 63 East Adams St., Chicago, Ill. Annual meeting at San Francisco, June 11-13.

American Boiler Manufacturers' Association. H. N. Covell, 191 Dikeman St., Brooklyn, N. Y. Annual meeting at the "Homestead," Hot Springs, Va. June 9-11.

American Order of Steam Engineers. W. S. Wetzler, 753 North 44th St., Philadelphia, Pa. Annual meeting at Moose Hall, 1314 North Broad St., Philadelphia, Pa., June 9-13.

American Society of Heating and Ventilating Engineers. F. C. Houghten, 29 West 39th St., New York City. Semi-annual meeting at Kansas City, Mo., June 10-12.

American Society of Mechanical Engineers, Calvin W. Rice, 29 West 39th St., New York City. Spring meeting at Cleveland, Ohio, May 26-29.

American Society of Refrigerating Engineers, W. H. Ross, 35 Warren St., New York City. Annual meeting at Cleveland, Ohio, May 27-29.

American Water Works Association. J. M. Diven, 153 West 71st St., New York City. Annual convention at New York City, May 19-21.

Canadian Association of Sationary Engineers. George J. Soucy, 48 Moore Ave., Toronto, Ont. Annual meeting, St. Thomas Ont., June 23-26.

Electric Power Club. S. N. Clarkson, Keith Bldg., Cleveland, Ohio. Meeting at Seaview Golf Club, Absecon, N. J., May 26-29.

International Railway Fuel Association. J. B. Hutchinson, 6000 Michigan Ave., Chicago. Annual convention at Hotel Sherman, Chicago, Ill., May 26-29.

Master Boiler Makers Association. H. D. Vought, 26 Cortlandt St., New York City. Meeting at Chicago, May 20-23, 1924.

National Association of Stationary Engineers. Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual convention and exhibition at Hotel Pantlind, Grand Rapids, Mich., Sept. 8-13. Annual conventions and exhibitions of the state associations are scheduled as follows: **Illinois Association** at Rockford, Ill., June 4-6. L. G. Schlemm, 805½ South Ninth St., Springfield, Ill. **New Jersey Association** at Newark, June 6-8. Joseph P. Flynn, 612 Franklin St., Elizabeth, N. J. **Iowa Association** at Sioux City, June 10-14. Abner Davis, 16 Waterhouse Block, Cedar Rapids, Iowa. **New York State** at Niagara Falls, June 13-14. William Adelyotte, Shredded Wheat Co., Niagara Falls. **Ohio Association** at Akron, June 19-21. T. S. Garrett, 2622 East Second St., Dayton, Ohio.

National Board of Boiler and Pressure Vessel Inspectors, C. O. Myers, 502 Comstock Bldg., Columbus, Ohio. Annual meeting at Cleveland Hotel, Cleveland, Ohio, May 26-29.

National District Heating Association, D. L. Gaskill, 112 West Fourth St., Greenville, Ohio. Annual convention at New York City, June 10-12.

National Electric Light Association. M. H. Aylesworth, 29 West 39th St. New York City. Annual convention at Atlantic City, Young's Million-Dollar Pier, May 19-24. **Nebraska Section,** H. M. Davis, Banker's Life Bldg., Lincoln, Neb. Sectional meeting at Omaha, May 8-9.

National Fire Protection Association. F. H. Wentworth, 40 Central St., Boston, Mass. Annual meeting, Atlantic City, N. J., May 13-15.

Smoke Prevention Association. Frank A. Chambers, 111 North Dearborn St., Chicago, Ill. Eighteenth annual convention at Hotel Statler, Buffalo, N. Y., June 3-5.

Stoker Manufacturers Association. G. A. Sacchi, Westinghouse Elec. & Manufacturing Co., Philadelphia, Pa. Annual meeting at Edgewater Beach Hotel, Chicago, Ill., June 2-4.

World Power Conference. O. C. Merrill, Federal Power Commission, Washington, D. C. British Empire Exhibition, Wembley, London, June 30-July 12.

Personal Mention

Prof. Elihu Thomson, who is to receive the Kelvin Medal at the World Power Conference in June, sailed on April 26 for a three months' tour of Europe.

F. A. Combe and **E. A. Ryan,** consulting engineers on steam-plant design and heating and ventilation, have removed their joint offices to 416 Phillips Place, Montreal, Canada.

E. W. Allen, formerly engineer and assistant manager of the central district of the General Electric Co., with headquarters in Chicago, has been appointed manager of the engineering department of that company.

Business Notes

The Conveyors Corporation of America, 326 W. Madison St., Chicago, Ill., has recently announced that on May 1 its New England representative, Colwell & McMullin, will be located in new offices in the Park Square Bldg., Boston, Mass.

The American District Steam Co., North Tonawanda, N. Y., broadcast a series of four talks recently on the subject "District Steam Heating in Lockport, N. Y.," by George H. West. These four papers may be secured by any reader upon application to Radio Station WMAK, Lockport, N. Y., or Mr. West at Tonawanda.

The Universal Coal Spreader Co., 53 West Jackson Blvd., Chicago, Ill., announces the appointment of agencies to handle its product: Alfred Campbell, Inc., Frick Building Annex, Pittsburgh, Pa.; Boiler and Equipment Supply Corp., 2 Rector St., New York, N. Y.; E. H. Bull & Co., 253 Jackson Blvd., Chicago, Ill.

The International Combustion Engineering Corp., 43 Broad St., New York City, has been showing a group of prominent foreign engineers, some of whom have recently become affiliated with its company, several of the larger plants in the United States using pulverized-fuel equipment. The party consists of: G. C. Usher, formerly with the Green Fuel Economizer Co.; F. H. Rosencrantz, formerly with the Electric Share & Bond Co.; R. A. Chattock, formerly chief engineer, City of Birmingham; G. G. Bell, chief engineer of electric department, Hammersmith, London; A. J. T. Taylor, president of Combustion Engineering Corp., of Canada; J. H. Millen, of the London Underground Railways; David Wilson, formerly chief of technical division of Babcock & Wilcox, Ltd., London; E. H. Cockshott, of the Underground Railways, London; Col. H. D. Savage, vice-president of the Combustion Engineering Corp., New York.

Among the plants that this party visited were, Colfax Station, Springdale Station, Cleveland Electric Illuminating Co., Milwaukee Electric Railway and Light Co., Cahokia and Ford Motor Works at River Rouge, and the Detroit Edison Co.

Trade Catalogs

Coupling, Shaft — Ajax Flexible Coupling Co., Westfield, N. Y. Catalog of 18 pages covers the merits, and also shows by means of photos numerous installations of these couplings. A price list and table of dimensions add to the value of the publication.

Fittings—The Hydraulic Press Manufacturing Co., Mount Gilead, Ohio, Bulletin 4302, "Drop Forged Fttings for Super-heat and Super-pressure," gives tables of dimensions and price lists of the various fittings. The catalog is well illustrated in two colors.

Conduit, Insulating — The Ric-Wil Co., Union Trust Bldg., Cleveland, Ohio, Catalog No. 6 describes this insulating conduit for underground steam and hot water pipes, condensation returns, fuel oil, etc. It is well illustrated and gives tables of dimensions.

Combustion Units—Duquesne Burner Service Co., Pittsburgh, Pa. Catalog No. 11 covers the general subject of combustion and gives descriptions and illustrations of the burners manufactured by this company. Tables of dimensions, tests of B. & W. boilers with Duquesne installations and lists of installations are included.

Fuel Prices

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine run bases, f.o.b. mines):

Coal	Market Quoting	Apr. 21, 1924	Apr. 28, 1924
Pool 1	New York...	$3.00	$3.00
Smokeless	Columbus....	2.35	2.35
Clearfield	Boston	2.40	2.35
Somerset	Boston	2.50	2.50
Kanawha	Columbus....	....	....
Hocking	Columbus....	1.75	1.75
Pittsburgh No. 8	Cleveland...	1.85	1.85
Franklin, Ill.	Chicago	2.50	2.50
Central, Ill.	Chicago	2.25	2.25
Ind. 4th Vein	Chicago	2.50	2.50
West Ky.	Louisville...	1.75	1.75
S. E. Ky.	Louisville ...	1.75	1.75
Big Seam	Birmingham	2.25	2.25

FUEL OIL

New York—May 1, light oil, tank-car lots, 28@34 deg., Baumé, 5½c. per gal., 36@40 deg. 6c. per gal., f.o.b. Bayonne, N. J.

St. Louis—April 29, tank-car lots, f.o.b. St. Louis; 24@26 deg., $1.90 per bbl.; 26@28 deg., $1.95 per bbl.; 28@30 deg., $2 per bbl.; 32@36 deg., gas oil, 5½c. per gal.; 38@40 deg., 6½c. per gal.

Pittsburgh—April 24, f.o.b. local refinery, 30@34 deg., fuel oil, 5½c. per gal.; 36@40 deg., fuel oil, 5¾c. per gal.; 34 deg., neutral, 8½c. per gal.

Dallas—April 25, f.o.b. local refinery, 26@30 deg., $1.30 per bbl.

Philadelphia—April 25, 28@30 deg., $2.415@$2.478 per bbl.; 18@22 deg., $2.10@$2.16½; 13@16 deg., $1.785@$1.848 per bbl.

Boston—April 22, tank-car lots, f.o.b. heavy oil, 12@14 deg. Baumé, 4½c. per gal., light oil, 28@32 deg. Baumé, 6½c. per gal.

Cincinnati—April 28, tank-car lots, f.o.b. local refinery, 24@26 deg., Baumé, 5½c. per gal.; 26@30 deg., 5¾c. per gal.; 30@32 deg., 6c. per gal.

New Plant Construction

Ala., Birmingham—The Standard Gas Products Co. plans construction of a steam power plant, to cost $160,000, with equipment.

Ala., Sheffield—The Tri-City Produce Co. plans cold storage equipment in its new building at Third and Franklin Sts., on which work has been commenced, estimated cost $40,000.

B. C., Prince Rupert—The Skeena Laminated Wood Co., Ltd., 522 Rogers Bldg., Vancouver, B. C., plans for the installation of a steam power plant at its proposed local mill, estimated to cost $200,000, for which plans will soon be prepared.

Calif., La Verne—The Board of City Trustees is considering the installation of electric-operated pumping equipment at proposed sewerage disposal works. Bonds of $60,000, have been approved.

Calif., San Diego—Plans are under way for three electric-operated pumping plants in connection with a proposed sewerage system in the Mission Beach section. F. A. Rhodes is city engineer.

Calif., Turlock—The Turlock Irrigation District has tentative plans under advisement for the construction of a $100,000 hydro-electric power plant at the La Grange dam, with capacity of 4,000 kw.

Conn., Danbury — The Danbury Iron Works, Inc., recently organized, is said to be planning for the construction of a boiler plant, to cost about $30,000. John Manacek, Danbury, is president.

Cuba, Camaguey—Moses B. de Marchena, local sugar operator, and associates have organized a new company under the name of the Siboney Sugar Co., to construct and operate a local mill. The installation will include a power house and pumping machinery. Estimated cost $1,200,000.

Fla., Bradentown—The Southern Utilities Co. is considering plans for extensions in its power plant, to include additional boilers, fuel oil system, turbo-generator and auxiliary apparatus, estimated cost $200,000.

Fla., Hialeah—W. C. Smith, Hialeah, plans for a steam power plant at his proposed furniture factory, estimated cost $75,000.

Fla., Tampa—The First Psychological Development Association, recently organized with a capital of $1,000,000, plans for the installation of a steam power house at its proposed hollow tile manufacturing plant in the Sulphur Springs section, estimated to cost $125,000. Dr. H. L. Clough is president.

Fla., Vero—The Indian River Fertilizer Co. plans for a steam power house at its proposed local plant, estimated at $45,000, with equipment.

Ga., Irwinton—The Akron Pigment Co. plans for a steam power house in connection with the proposed rebuilding of its local plant.

Idaho, Post Falls—Edwin S. Crane, Post Falls, and associates, plan a hydro-electric plant on the Spokane River, to cost $100,000.

Ill., Waukegan—The North Shore Sanitary District, Highland Park, Ill., considers the installation of electric-operated pumping equipment at its proposed sewerage disposal works on the Darrenger Road, Waukegan, estimated to cost $200,000. Pearce, Greeley & Hanson, 6 N. Michigan Ave., Chicago, engineers.

Ind., Columbus—I. C. Morgan, Columbus, plans an ice and refrigerating plant, estimated cost $100,000, with equipment.

Ind., Indianapolis—The Indiana Electric Corp., Guarantee Bldg., is said to have authorized Stone & Webster, Inc., 147 Milk St., Boston, Mass., engineer, to prepare plans for a hydro-electric power plant in the vicinity of Macksville, Ind., estimated to cost $225,000.

Kan., Burlington—The Common Council plans electric-operated pumping equipment at the proposed sewerage disposal works, estimated to cost $45,000. Black & Veatch, Mutual Bldg., Kansas City, Mo., are engineers.

Ky., West Hickman — The Bondurant Cotton Ginning Co. is considering plans for the rebuilding of the portion of its cotton gin and boiler plant.

Ky., Wilmore—The Board of Trustees, Asbury College, has tentative plans for rebuilding steam power house recently destroyed by fire.

La., Houma—The Grand Caillou Packing Co., P. O. Box 458, recently organized, plans a boiler plant at its proposed fish-canning factory, estimated cost $75,000. E. M. Lapeyre, secretary.

Md., Annapolis—The navy supply office has been authorized to purchase six d.c. motors, as per Naval Requisition 459.

Md., Baltimore—Henry T. Heinz, 128 Landwelir Lane, meat packer, plans for a refrigerating plant, estimated to cost $85,000.

Md., Hagerstown—The Harloe Tire Co., Winchester, Va., plans a boiler plant at its proposed mill, estimated to cost $65,000. The present Winchester works will be removed to the new location.

Md., Havre De Grace—The City Council will perfect plans in the near future for the proposed municipal electric power plant, for which an appropriation of $300,000, was approved by the recent state legislature.

Md., Salisbury—The Salisbury Ice Co. has authorized plans for the erection of a new cold storage plant on site recently acquired on Naylor St., estimated to cost about $70,000, with equipment.

Mass., Everett—A steam plant will be constructed at the proposed blast furnace of the Massachusetts Gas Co., 111 Devonshire St., Boston, Mass., to be operated by a subsidiary organization. A note issue of $5,000,000, is being sold.

Mich., Battle Creek—The Grand Trunk Western Lines, Battle Creek, D. T. Crawford, superintendent, plans for a steam power house at its proposed local engine house and repair plant on Hall St., reported to cost $150,000. Bids will be asked in May.

Mich., Detroit—The Detroit Edison Co., 2000 Second St., is taking bids until May 15, for foundations and superstructure work for a new power plant at French Landing, about 20 miles from the city, on the Huron River. Gardner S. Williams, Cornwell Bldg., Ann Arbor, Mich., is consulting engineer.

Mich., Grand Rapids — The Board of Works, Fred H. Locke, city manager, has tentative plans for the installation of electric-operated pumping equipment at the proposed sewerage disposal plant, estimated to cost in excess of $1,000,000. Plans are being drawn by C. O. Paige, City Hall, city engineer.

Mich., Grand Rapids—The Consumers Power Co., Jackson, Mich., has authorized plans for the construction of an addition to its steam-operated power plant on Wealthy St. to cost about $1,500,000, including equipment. The company will also build a third unit to its steam-operated electric station on the Saginaw River.

Mich., Rapid River—New interests have acquired the power plant and property of the Rapid River Electric Light Co. heretofore operated by H. E. Pfeifer. Plans are under way for extensions and betterments.

Miss., Jackson — The Eagle Lumber & Supply Co., recently formed with a capital of $300,000, plans for the construction of a boiler plant at its proposed lumber mill on tract of property just purchased, estimated to cost $100,000. A. B. Wicks heads the company.

Miss., Moselle — The Moselle Farmer's Gin Co., plans for the installation of a crude oil engine and auxiliary power equipment at its proposed local cotton ginning plant. J. M. Bryant is head.

Mo., Chillicothe—Bids will be received by Jewell Miller, city auditor, until May 16, for equipment for a municipal steam power house, including one 500 hp. water-tube boiler, with superheater, stoker and accessory apparatus; brick or concrete stack, 7 ft. diam. and 175 ft. high; remodeling and improvements in present boiler plant. E. E. Harper, 3031 Park Ave., Kansas City, Mo., is consulting engineer.

Mo., Hartsville—The Common Council will soon ask bids for the construction of its proposed municipal hydro-electric power station, for which plans are being completed by the Alexander Engineering Co., Woodruff Bldg., Springfield, Mo., engineer.

Mo., Kansas City—The Iten Biscuit Co., 1202 Capital Ave., Omaha, Neb., plans for the installation of a boiler plant at its proposed two-story and basement factory at Twenty-fifth and Madison St., estimated to cost $130,000. Albert C. Arend, First National Bank Bldg., Kansas City, is consulting engineer.

Mo., Monett—The Common Council will make extensions and improvements in the steam power plant, to cost about $85,000.

Mo., Perryville—The Common Council contemplates the installation of electric-operated pumping equipment in connection with proposed extensions and improvements in the municipal waterworks, estimated to cost $75,000.

Mo., Potosi—The Common Council is considering electric-operated pumping equipment in connection with a new waterworks and sewerage system, estimated to cost $50,000. The Alexander Engineering Co., Woodruff Bldg., Springfield, Mo., is engineer.

Mo., Springfield—The Board of Public Works plans for the installation of electric-operated pumping equipment in connection with proposed extensions and improvements in the municipal waterworks, for which a bond issue of $350,000 has been passed. The Burns & McDonnell Engineering Co., Interstate Bldg., Kansas City, Mo., is engineer.

Mo., Springfield—The Springfield Packing Co., recently formed with a capital of $500,000, plans for the installation of an ice and refrigerating plant at its proposed three-story meat-packing plant on the Mill Road, estimated to cost $150,000. Heckenlively & Marks, Springfield, are architects. W. E. Banks is president.

Mont., Dillon — The Common Council plans for electric-operated pumping equipment in connection with proposed extensions in the waterworks, estimated to cost $100,000. Bonds will be voted in June.

Mont., Missoula—The Dover Logging Co., Coeur d'Alene, Idaho, plans for the construction of a steam power plant at its proposed lumber mill on Marten Creek in the Cabinet Forest, near Missoula, estimated to cost $250,000, including a logging railroad.

Neb., Beatrice—Swift & Co., Union Stock Yards, Chicago, Ill., meat packers, plan an ice and refrigerating plant in their proposed local three and four-story packing plant, estimated to cost $105,000, with equipment.

Neb., Lincoln — The Roberts Sanitary Dairy Co. has tentative plans for a refrigerating plant, to cost $85,000. Will be located at N and Twentieth Sts.

Neb., Pender—Mark J. Ryan, city clerk, will receive bids until May 13 for two motor-driven centrifugal pumps and auxiliary equipment for pumping station, for waterworks extensions. The Prince-Nixon Engineering Co., Omaha Grain Exchange Bldg., Omaha, Neb., is engineer.

N. Y., Attica—The Common Council plans for the installation of electric-operated pumping equipment in connection with proposed extensions in the municipal waterworks, estimated to cost $55,000. Plans will soon be drawn.

N. Y., Brooklyn—The General Baking Co., 342 Madison Ave., New York, plans for a steam power house at Washington and Lefferts Aves., estimated to cost $300,000, for which a general building contract has been let to the Turner Construction Co., 244 Madison Ave., New York.

N. Y., Hudson—The Canada Dry Ginger Ale Co., 544 West 38th St., New York, is said to be planning for a boiler plant at its proposed factory, estimated to cost $60,000.

N. Y., Liverpool—The Common Council plans for electric-operated pumping equipment in connection with its proposed new waterworks plant and system, estimated to cost $145,000.

N. Y., Long Island City—The Astoria Silk Corp., 723 Steinway Ave., has authorized an addition to its steam plant, estimated to cost $200,000. Ophus & Hill, 112 West 42nd St., New York, engineers.

N. Y., New York—The New York Edison Co., Irving Place and Fifteenth St., has plans in progress for the construction of a steam-operated electric generating plant at East Fourteenth St. and the East River, designed as one of the largest such stations ever built, estimated to cost $25,000,000, with power lines, etc. Ernest Van Norden is company engineer.

N. Y., New York—The New York Steam Corp., 280 Madison Ave., has preliminary plans under way for extensions in its plants and system.

N. Y., Perry—The Dairymen's League Co-Operative Association, 333 Lafayette St., Utica, N. Y., plans an ice and refrigerating plant, estimated cost $150,000, with equipment.

N. Y., Syracuse—The Syracuse Lighting Co. is said to be arranging plans for the construction of a hydro-electric generating plant on the Salmon River, estimated to cost $750,000. The company is a subsidiary of the United Gas Improvement Co., Broad and Arch Sts., Philadelphia, Pa.

N. Y., Troy—The Troy Coke & Iron Co., Inc., recently organized by officials of the Burden Iron Co., with local mill, plans for the construction of a steam power plant at its proposed local steel plant, estimated to cost $1,750,000, with machinery. Work is expected to be placed in progress in June.

N. C., Aberdeen—T. J. Horton & Co., P. O. Box 157, are planning for the early purchase of a crude oil engine and auxiliary equipment.

N. C., Bryson City—The Board of Aldermen is disposing of a bond issue of $100,000, the proceeds to be used for the installation of a municipal hydro-electric power plant. Plans have been prepared.

N. C., High Point—The Common Council is considering the installation of electric-operated pumping equipment in connection with proposed waterworks extensions, estimated to cost $200,000. E. L. Ragan is secretary.

N. C., Spindale—The Common Council plans for the installation of electric-operated pumping equipment in connection with extensions in the waterworks plant and system, estimated to cost $100,000. Bonds will be voted at an early date.

Ohio, Toledo — The Board of Directors, Lutheran Orphanage, 2411 Beaman St., has completed plans and authorized construction for a steam power house and mechanical laundry, estimated to cost $100,000, with equipment. Bates & Gamble, Close Bldg., are architects.

Ohio, Wadsworth—The Common Council plans for electric-operated pumping equipment at its proposed sewerage disposal works, estimated to cost $110,000. Bids will be asked about May 8. R. E. Garvin, Davis & Farley Bldg., Cleveland, Ohio, is engineer.

Okla., Altus—The Baker Cotton Oil Co. will build a steam power plant at its proposed cottonseed oil mill, on which work is in progress. William Baker is president.

Okla., Heavener—The City Council, C. W. Mizell, city manager, plans for the installation of an electric-operated pumping plant at the proposed waterworks station, estimated to cost $155,000. Bonds will be voted in the near future. V. V. Long & Co., Colcord Bldg., Oklahoma City, Okla., are engineers.

Ore., Bend—The Pringle Falls Power & Water Co. is perfecting plans for the construction of a hydro-electric generating plant on the Deschutes River, with initial capacity of 6,750 hp., to be increased at a later date. The power site is about 40 miles from the city.

Ore., Eugene—The J. O. Olsen Mfg. Co. plans for the construction of a steam power house at its proposed sash and door manufacturing plant on site selected near the western city limits, estimated to cost $50,000.

Pa., Berwick — The American Car & Foundry Co. plans for a steam power house at its proposed box car manufacturing works.

Pa., Durant City—W. A. James, Kane, Pa., and associates, are organizing a company, capitalized at $2,000,000, to construct and operate a glass manufacturing plant. It will include a steam power house.

Pa., McKees Rocks—The Lockhart Iron & Steel Co. plans for a boiler plant in connection with the rebuilding of its local mills, recently destroyed by fire. C. J. Gillespie is president.

Pa., Philadelphia—The Endura Mfg. Co., 63rd and Eastwick Sts., has preliminary plans for the rebuilding of its mill and steam power house recently destroyed by fire.

Pa., Philadelphia — The Philadelphia Rapid Transit Co., 810 Dauphin St., is planning for a rotary converter and auxiliary equipment at its Ranstead power station, estimated to cost $50,000.

Pa., Pittsburgh—The Chief of Engineers, United States Army, Washington, D. C., has authorized plans for two hydro-electric power plants at Locks 7 and 8, respectively, Monongahela River. Bids will be asked by the local district engineer.

Pa., Reading—The Reading Hardware Co. has taken out a permit to erect a steam power plant, to cost about $85,000. Work will proceed at once.

S. C., Bamberg—R. A. Easterling, Denmark, S. C., has preliminary plans under consideration for an ice-manufacturing and cold storage plant, to cost $50,000.

S. C., Clinton—The Lydia Cotton Mills have commissioned Lockwood, Greene & Co., of Atlanta, Ga., and 24 Federal St., Boston, Mass. to design and supervise the installation of power and lighting in its old mill and the complete electrification of the new extension.

S. D., Sioux Falls—The Sewer and Water Commission has authorized plans for a sewerage disposal works, with electric-operated pumping equipment. A call for bids is expected at an early date. The city engineer is in charge.

Tenn., Cookeville—The Common Council has commissioned V. V. Long & Co., Oklahoma City, Okla., engineers, to prepare plans for an extension in waterworks and new sewerage plant, with electric-operated pumping equipment, estimated to cost $100,000.

Tex., Amarillo—The Pan-Tex Pine Line Co., Amarillo, plans for a series of pumping plants, estimated cost $300,000.

Tex., Houston — The Houston Cotton Mills, Inc. has plans under way for a boiler plant. J. E. Sirrine & Co., Greenville, S. C., are engineers.

Tex., Lubbock—The Board of Directors, Texas Technological College, P. W. Horn, president, Fort Worth, Tex., plans for a power house at the proposed new institutional buildings, estimated to cost $1,000,000.

Tex., Mineola—The East Texas Public Service Co., Marshall, Tex., has acquired the plant and property of the Mineola Light, Ice & Power Co. The new owners plan for extensions.

Tex., San Antonio — The Planters' & Manufacturers' Cotton Mill Co., Inc., recently organized, will build a steam power house at its proposed mill, estimated to cost $1,000,000. Similar mills and power plants will be constructed later at Austin and San Marcos, Tex. S. M. Ramsopher of the Planters' & Merchants' Mill, New Braunfels, Tex., is one of the heads of the new company.

Va., Norfolk—The International Cement Corp., 342 Madison Ave., New York, plans for a steam power plant. Holger Struckmann is president.

Wash., Bellingham—The City Council plans electric-operated pumping equipment in connection with proposed extensions and improvements in the municipal waterworks, estimated to cost $200,000. J. C. Hills, is city engineer.

Wash., Bremerton—Hendrick Rosebloom, Bremerton, plans for an electric-operated pumping plant on Wildcat Lake, for proposed water supply. Application has been made to the State Water Department for permission.

Wash., Silverdale—Louis C. Mory, Silverdale, plans for a hydro-electric power station on Dickenson Creek. Application has been made to the State Water Department.

Wash., Yakima—The City Council has tentative plans under advisement for extensions and improvements in the municipal waterworks, including the installation of electric-operated pumping equipment, estimated to cost $500,000.

W. Va., Huntington—The United States Engineer will take bids until May 28 for the construction of a power house at Dam 32, Ohio River.

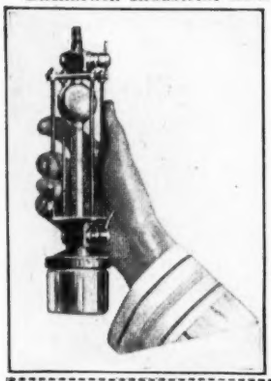
W. Va., Piedmont—The Common Council is considering electric pumping equipment in connection with proposed extensions to the municipal waterworks. Bonds for $30,000 have been voted.

W. Va., Williamson—R. L. Williamson and H. K. Hunt, of Williamson, plan for a steam power house at their proposed lumber plant.

Condensed-Clipping Index of Equipment

Condensed from previous descriptions in "Power" for convenient filing

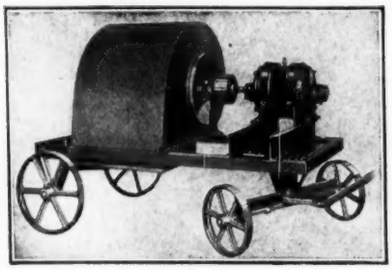
CO_2 Indicators, Pocket "Power," 1924.
Bacharach Industrial Instrument Co., Pittsburgh, Pa.



Convenient instruments for measuring CO_2 are a necessity to-day as economy in fuel is obtained through proper combustion. Proper combustion is determined by the percentage of CO_2 contained in the gases of combustion, which can be easily measured. The pocket indicator is simple and convenient to carry and no auxiliary apparatus is required for its use. The indicator is put up compactly in a box.

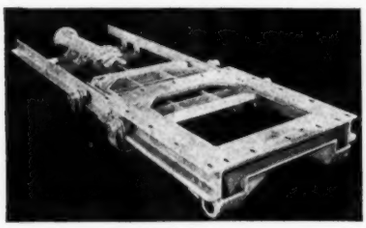
Fan Unit, Portable Motor-Driven "Power," 1924.
Buffalo Forge Co., Buffalo, N. Y.

This portable fan unit is especially adapted to furnace cooling in steel mills and ventilating tunnels or other services where a supply of air is required temporarily and where the installation of a permanent unit is not warranted. The units are made in several sizes. The fan and motor are mounted on a four-wheel truck with a handle attached for hauling purposes. The fan is of the duplex conoidal type, and is direct connected to the motor by means of a flexible coupling.

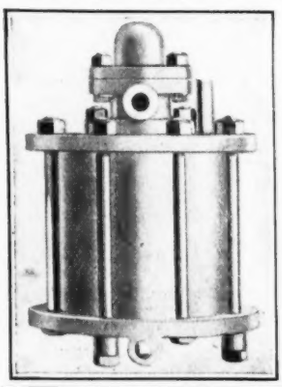


Ash Gate, Power Operated "Power," 1924.
Baker-Dunbar Co., Cleveland, Ohio.

A power-operated ash gate equipped with collecting trough to eliminate flooding of the basement. A stationary collecting trough is used at one end and conducting channels at right angles to it are cast integrally with the moving door. The channels are mechanically and automatically cleaned at each stroke of the gate by scrapers attached to the frame. The outlet from the collecting trough is piped to a drain.

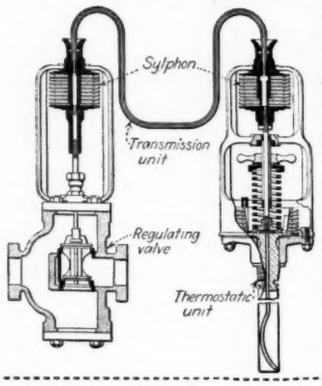


Steam Trap, All Steel "Power," 1924.
C. E. Squires Co., Cleveland, Ohio.



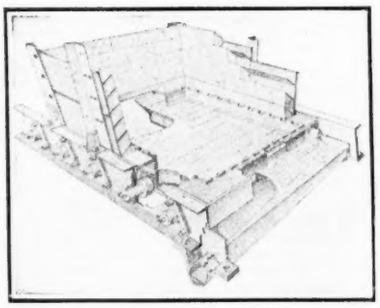
A new steam trap constructed entirely of steel and adapted especially to high pressure and high superheat. The body is constructed of two heavy steel plate flanges recessed on one side to receive a gasket and a short piece of extra-heavy pipe, the whole being bolted together with over-all bolts. The trap is of the bucket type, the principle of operation being the same as used in the regular line of traps manufactured by this company.

Temperature Control Instrument, Sylphon "Power," 1924.
The Fulton Co., Knoxville, Tenn.



A new temperature control instrument consisting essentially of three parts, a regulating valve, transmission unit and a thermostatic element. The regulating valve is installed in the steam supply line and the thermostatic element in the tank in which the temperature is to be controlled. They are then connected by means of a flexible tube that is fitted with a sylphon on each end and is attached to the valve and element through a T-slot connection. The valve and element may be placed a considerable distance apart or in a rather inaccessible position, the transmission unit being made any desirable length to suit installation requirements.

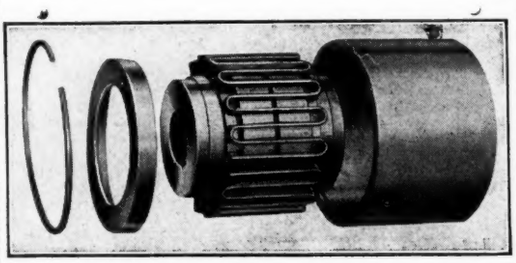
Ash Hopper and Gate "Power," 1924.
Allen-Sherman-Hoff Co., Philadelphia, Pa.



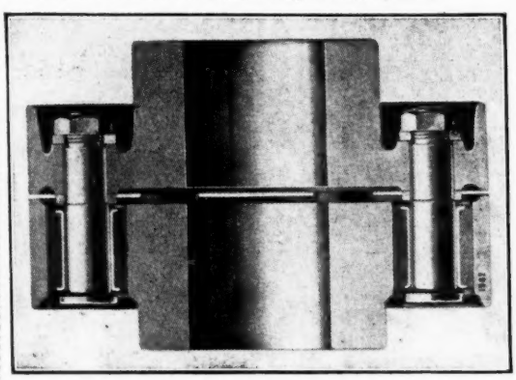
A sectional cast-iron ash hopper fitted with a power-operated gate. The hopper is lined with refractory tile, each layer supported by cast-iron ledges. The gate is constructed in the form of a tray, with flanges on three sides 4 in. high, and with one end removed. The water used for quenching discharges from the open end into a cast-iron trough that is piped to waste. The gate is effectively water-sealed against air infiltration or gas leakage.

Couplings, Flexible, Falk-Bibby "Power," 1924.
The Falk Corp., Milwaukee, Wis.

The problem of building a flexible coupling capable of transmitting the full torque of the shaft, but of not excessive dimensions, has always interested designers. The Falk Corporation, Milwaukee, Wis., has solved this by developing the Bibby spring coupling for practically all grades of service. This coupling consists of two flanges having grooves in their outer circumferences, into which is slipped a ribbon spring. This spring carries the load, and its elasticity is such that all vibrations are dampened out.



Couplings, Flexible "Power," 1924.
De Laval Steam Turbine Co., Trenton, N. J.



In this coupling the rubber bushings which provide the flexibility between the flanges are vulcanized to steel spools with a view to protecting them from wear by the driving bolts. Alignment is checked from periphery of couplings.

For a permanent file of new and improved power-plant equipment, clip and paste on 3 x 5-in. cards. (Patented Aug. 20, 1918.)